AFWAL-TR-80-4102 Part I

LEVEL II

AD A100496

PACER LIME: An Environmental Corrosion Severity Classification System

Robert Summitt
Fred T. Fink
Metallurgy, Mechanics, and Materials Science
Michigan State University
East Lansing, Michigan 48824

August 1980

Technical Report
Final Report for Period 15 Sept. 1978 - 31 Dec. 1979

Approved for public release;
distribution unlimited

MATERIALS LABORATORY
AIR FORCE WRIGHT AERONAUTICAL LABORATORIES
AIR FORCE SYSTEMS COMMAND
WRIGHT - PATTERSON AFB, OH 45433

NOTICE

When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the government may have formulated, furnished, or in any supplied the said drawings, specifications, or other data, is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture use, or sell any patented invention that may in any way be related thereto.

This report has been reviewed by the Office of Public Affairs (ASD/PA) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

Charles T. Lynch

CHARLES T. LYNCH
Project Engineer
Metals Behavior Branch
Metals and Ceramics Division

W. Reimann

WALTER H. REIMANN
Acting Branch Chief
Metals Behavior Branch
Metals and Ceramics Division

"If your address has changed, if you wish to be removed from our mailing list, or if the addressee is no longer employed by your organization please notify AFWAL/MLLN, W-PAFB, OH 45433 to help us maintain a current mailing list".

Copies of this report should not be returned unless return is required by security considerations, contractual obligations, or notice on a specific document.

19 TR-80-4102-PT-1

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER 18 AFWAL/TR-80-4102 Part I	2. GOVT ACCESSION NO. AD-A100	3. RECIPIENT'S CATALOG NUMBER 496
4. TITLE (and Subtitle) 6 PACER LIME: An Environmental Corrosion Severity Classification System, Part I.		5. TYPE OF REPORT & PERIOD COVERED Final [illegible] Sept [illegible]
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) 10 Robert/Summitt ~~and~~ Frederick T./Fink 15		8. CONTRACT OR GRANT NUMBER(s) F33615-78-C-5224 new
9. PERFORMING ORGANIZATION NAME AND ADDRESS Michigan State University Division of Engineering Research East Lansing, MI 48824 16		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 39300001 17 00
11. CONTROLLING OFFICE NAME AND ADDRESS Materials Laboratory Air Force Wright Aeronautical Laboratories Air Force Systems Command Wright-Patterson AFB, OH 45433	11	12. REPORT DATE August 1980
		13. NUMBER OF PAGES 12 122
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) 9 Final rept. 15 Sep 78-31 Dec 79,		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Corrosion, environmental severity, aircraft maintenance

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A system has been developed for rating the corrosivity of aircraft operational environments. This system takes account of weather, atmospheric pollutant, and geographical factors to compute a severity index for three aspects of corrosion maintenance: aircraft washing, repainting, and repair needs. Computed ratings are in good agreement with aircraft corrosion experience and atmospheric testing programs at several locations.

DD FORM 1 JAN 73 1473

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

PREFACE

This is the Final Report for USAF Aeronautical System Division Contract No. F33615-78-C-5224 (Project 3930 Task ØØ, Work No. 01) with Michigan State University. The Program described was initiated by personnel of Warner-Robins Air Logistics Center Corrosion Management Office (WR-ALC/MMETC). Its objective is to develop an environmental corrosion severity classification system and to calibrate this system by means of an atmospheric testing program. After several years of development and testing by WR-ALC, analysis of the results was completed by MSU. The Final Report is divided into two parts which are issued separately. This, the first part, discusses the environmental classification system and the second part treats the experimental phase.

This Program has spanned several years and represents the efforts of many people. Particular acknowledgement must be made for several of them. The USAF Project Engineer was Dr. C. T. Lynch, AFWAL/MLLN, and we have benefitted from his continued encouragement as well as that of Col. William Egan and Lt. Col. Garth Cooke, AFLC/LOE, all at Wright-Patterson AFB, Ohio. Several people worked on earlier stages of the program at Robins AFB, Georgia, including Col. (Ret.) Harold L. Beasley, Lt. Col. (Ret.) James Upp, Capt. (Ret.) Terry Rickard, Capt. J. G. Knapik, Lt. Lane Hogue, Mr. William Richardson, Mr. William Thompson, and Mr. Frank Denton. At MSU Graduate Assistants Dave Bursik, Matt Rizai, and Nina Samsami, Undergraduate Assistants Carolyn Wright, Mike Tichvon, Caroline Sokalski, Angelica Bodnar, and Holly Tallon all have made valuable contributions to the research. Finally, Undergraduate Assistant Andrea Cerulli has served as editor for this Report. We thank all for their work.

TABLE OF CONTENTS

TABLE OF CONTENTS (CONT.)

LIST OF ILLUSTRATIONS

LIST OF TABLES

I. INTRODUCTION

Several studies have centered on the total costs of corrosion prevention and control within the past few years.[1-5] The inescapable conclusion is that total corrosion costs for aircraft maintenance and management are an intolerable burden to the Air Force in terms of maintaining force effectiveness at reasonable cost to the taxpayer. Direct costs of corrosion maintenance for major aircraft systems in the field and at depot level have been estimated to be in excess of $750 million per year, and total corrosion costs, including those for airbase facilities, are estimated to be in excess of $1 billion per year.[4] A key factor in controlling these costs is the ability to optimize corrosion repairs based upon need, rather than the current practice to perform them at fixed time intervals, and, in the field or at depot, based upon optimized inspection, need, and time of repair. The current program of fixed time interval depot maintenance of aircraft, under Programed Depot Maintenance (PDM), does not correspond to the actual corrosion damage level of individual units.[6] Thus, the method results in inefficient and uneconomical use of facilities and resources. The scheduling of depot maintenance could be based, however, on the cumulative exposure to corrosion risks if the risk factors were identified and quantified and the relations between exposure and damage were known.

One approach to quantifying risk factors is to classify the environmental severity according to the nature and intensity of ambient corrosive factors. It has long been acknowledged that some environments are more corrosive than others, and environments are commonly classified as industrial, urban, or marine, thus indicating their approximate severity.[7,8] It also is established that certain environmental constituents, e.g., sea salt and sulfur dioxide, increase the relative aggressiveness of the environment.[9,10] An environmental classification, based on the atmospheric

constituents present, might be used as a guide in establishing the maintenance schedules required for complex systems, such as aircraft.

In response to the needs of the Strategic Air Command (SAC), the AF Logistics Command (AFLC) implemented a program* to develop a corrosion severity classification for each operational airbase as part of the Corrosion Prevention and Control (COPCON) program (redesignated as Project RIVET BRIGHT in 1971). Program development began in 1965 and implementation was achieved in 1971. The program was designated PACER LIME in 1972 as an element of RIVET BRIGHT. PACER LIME is a two phase effort: (1) Development of an equation or algorithm for computing a priori a numerical corrosion factor which combines weather and other environmental factors; (2) experimental measurement of corrosion severity at selected locations through atmospheric corrosion tests. The experimental data would be used to "calibrate" the computed corrosion factor.

An initial corrosion factor equation, combining certain weather and geographical factors, was developed in 1971. Interim numerical classifications were published for 39 SAC airbased in 1972, and for 95 USAF and 27 ANG airbases in 1973. A complete list was distributed in 1974 under the title "PACER LIME Interim Corrosion Severity Classification." These interim values were to be compared with corrosion maintenance experience and the results of the PACER LIME atmospheric testing program. The corrosion factor equation then would be modified and used to compute working corrosion severity classifications. The experimental phase produced useful data very slowly, however, and analysis of maintenance experience proved to be more complex than expected. Consequently, revision of the corrosion factor equation has been delayed considerably.

*Records of the Program were the source for the following discussion. These records are the property of USAF Corrosion Management Office, MMETC, Robins AFB, GA.

The need for environmental guidelines was so great, however, that the Interim Classifications were soon used to develop maintenance interval guidelines, e.g., for washing and corrosion inspections. In several cases these guidelines correlated poorly with field-level experience and a few computational errors had occurred. Thus, the validity of the guidelines and the corrosion factor equation was severely questioned.

The experimental phase of PACER LIME would provide a calibration reference point for the corrosion factor equation by measuring corrosion rates at several airbases. The test sites were selected in order to span the range of environments from mildest to most severe. Alloys representative of those used in modern airframe construction were chosen for outdoor exposure. Program planning was completed in 1971, most test stands were installed in 1972, while the remaining stands were installed in 1973 and 1975. Despite numerous difficulties and misfortunes, considerable data was accumulated between 1972 and 1978. Analysis of the data, in terms of environmental parameters, however, proved to be more complex than expected.

In 1978 it was determined that adequate in-house USAF resources could not be made available for the completion of PACER LIME, and the Program was assigned under contract to Michigan State University. The objectives of the MSU effort were to complete the program by analyzing results of the corrosion exposure test program, the Base Corrosion Severity Classification System, and to develop an improved classification system. This improved system was to be applied to the environments of all USAF, AFRES, and ANG airbases in order to provide ratings for each. These objectives have been accomplished and are discussed in this Final Report.

The Report is divided into two parts, which are being published separately. The first part discusses the Corrosion Severity Classification System and the second part the Corrosion Exposure Test Program.

II. THE CORROSION SEVERITY CLASSIFICATION SYSTEM

1. Environmental Variability

The variability of environmental corrosion severity has been well established by atmospheric testing programs.[8,11-14] Relative severity is commonly indicated by designating an environment as rural, urban, industrial, marine, or an appropriate combination of these terms. Moreover, many studies[7,9] have shown that certain environmental factors, e.g., moisture, salt, and pollutants, are responsible for the more rapid corrosion observed in environments containing them. Consequently an environmental rating scale which takes into account those factors could provide a more useful indication of relative severity which could be used in management of aerospace systems.*

It would be difficult to devise a general rating system which would predict the corrosion damage to every metal. Different metals display widely diverse behavior in a given environment and also from one environment to another. Some alloys are more resistant in marine locations than industrial, and the reverse is true for others. The several factors which influence corrosion are present in a unique combination for a given site, and precise information relating the corrodibility of a specific alloy to every environmental factor is not available. In the case of aircraft, however, one is concerned with a limited number of alloys, a few each of aluminum, steel, titanium, and magnesium.** In addition, a precise rating scale is not needed for logistic decisions, but merely a relative rating. It is commonly known that aircraft - like automobiles - are corroded more severely in some environments than others. Finally, since military aircraft spend most of their lifetime on the ground at the

---

*And other systems as well, cf. Scheffer[15].

**The scope of this study is restricted to corrosion of structural alloys, excluding engines and avionics. Materials of these latter systems, however, probably will respond to environmental corrosive factors in a similar way[16].

home airbase,[6] a system for classifying the severity of airbase environments is quite reasonable.

2. Atmospheric Corrosion in Aircraft

Tomashov[7] distinguishes the following types of atmospheric corrosion:

(1) "Wet atmospheric corrosion" caused by visible droplets of condensed moisture on the surface. Such moisture may result from dew, frost, rain, snow, or spray;

(2) "Moist atmospheric corrosion", which occurs at relative humidity less than 100%, and proceeds under a very thin, invisible layer of electrolyte formed on the surface by capillary action, physical, or chemical adsorption;

(3) "Dry atmospheric corrosion" which occurs in the complete absence of a moisture film.

Both wet and moist atmospheric corrosion occur in aircraft. Water accumulates on metal surfaces as condensation (dew, fog, from humid air on cold post-flight surfaces), rainfall on exterior surfaces and through open hatches, and various inadvertant spills. Dry atmospheric corrosion, however, is unimportant because aircraft alloys do not corrode in the absence of moisture.

Thus the range of corrosion problems in aircraft may be categorized as:

(1) Wet and moist corrosion of bare, unprotected metal surfaces;

(2) Wet and moist corrosion of protected metal surfaces subsequent to failure of protective coatings. Protective coatings fail because of solar radiation, atmospheric contaminants (mainly ozone and other oxidants, particulates, fuels, and exhaust gases), high speed air ablation, and mechanical abrasion and flexure;

(3) Corrosion caused by contaminants of human origin including spilled beverages, human waste, hydraulic fluids, and battery acids.

The first and second categories of corrosion may be related to the ambient environmental factors which accelerate

corrosion of metals or degradation of protective coatings, hence an environmental rating system would be relevant to them. The third category is a housekeeping problem. Although it should be relatively easy to control and prevent such damage, it is in fact a serious problem in USAF aircraft. The quality of housekeeping varies from one airbase to another[6] and thus conceivably might be considered an environmental variable. Since it is not easily measured, and it varies unpredictably from time to time, it cannot be considered in a rating system.

3. Factors Affecting the Rate of Corrosion

The rate of metallic corrosion in the atmosphere is determined by three sets of variables:

(1) Weather conditions, especially those relating to moisture;

(2) Atmospheric pollutants, both natural and anthropogenic;

(3) The nature of the metal.

The relationship of weather and pollutants to the corrosion of aircraft alloys of interest in PACER LIME will be discussed in some detail.

a. Weather

Weather parameters include temperature, precipitation, solar radiation, wind direction, wind speed, relative humidity, dew point, cloud cover, and fog.[10] All can affect the rate of corrosion, but water (and therefore those parameters related to water) will produce the largest influence. Vernon[17,18] has shown that a given metal corrodes rapidly when the relative humidity exceeds a critical value, but corrodes slowly or not at all at lower humidity. The value of the critical humidity varies from one metal to another, and the presence of various pollutants can change the value as well as the corrosion rate. The critical humidity for ferrous alloys is about 70% in the absence of other factors; in the presence of sulfur dioxide, however,

it is reduced to about 60%. Similarly in the presence of SO_2, the critical RH is about 70% for aluminum. Unfortunately very few data are available for other metals.

A film of moisture will deposit from humid air on metal surfaces of aircraft[19] under several conditions: if the metal is colder than the air (immediately following high altitude flight), if hygroscopic salts (corrosion products, pollutant deposits) are present, or through adsorption. The film thickness, from two or three to several hundred molecular layers, will be determined by the humidity value as well as the nature of the adsorption process.[7] Consequently, the relative humidity alone is not sufficient to determine completely relative corrosivity, but it can provide a good first approximation.

Dew, fog, and rain, on the other hand, wet exposed surfaces immediately. Dew condensation occurs when air cools to its dew point temperature, corresponding to 100% RH. The air itself need not cool to this point, however, before moisture accumulates. The only requirement is that the metal surface be sufficiently cooler than the surrounding air. At 80% RH, for example, the surface need be only 6°F cooler than the air.[19]

There has been much discussion[10] on the effects of rainfall. Rain is thought to promote corrosion by providing moisture and washing away soluble corrosion products. It also is believed to retard corrosion by washing away pollutant deposits. Thus light rain would be harmful, but heavy rain would be beneficial.

The beneficial effects appear to be unimportant in aircraft corrosion, because, generally, paint protects aircraft surfaces exposed to the washing effects of rain, whereas corrosion occurs underneath the paint at cracks, etc., where the washing is ineffective. Interior surfaces carelessly exposed to rain, however, are wetted and not washed, and water is harmful to the less well protected surfaces. Accordingly, rain should be considered a harmful source of moisture.

Air temperature, humidity, solar radiation, cloud cover, and wind speed affect the rate of water evaporation. Also, temperature strongly influences the rate of corrosion reactions, thus corrosion rates would be expected to increase as the temperature rises. But oxygen, dissolved in the water electrolyte, is required for most corrosion reactions and the solubility of gases decreases with increasing temperature.

Rozenfeld[9] considers in some detail the interaction of temperature and moisture, and points out that the time of wetness will vary with temperature. Thus corrosion rates are greater in northern regions, where temperatures are low, than in warmer southern regions because moisture remains on metal surfaces longer at the cooler northern temperatures, but evaporates faster in southern warm temperatures. A combination of high temperature with prolonged moisture contact, however, will result in severe corrosion. For example, corrosion of marine pilings in summer is rapid near the water surface where they are wetted continually, but quite low at higher points where they are wetted only occasionally by rain. It remains difficult to predict, though, the effect of temperature on corrosion processes in the atmosphere.

b. Pollutants

Atmospheric pollutants are natural and anthropogenic airborne substances present at harmful concentrations. These substances usually are described as follows,[20] including only those known to contribute to corrosion:[21]

(1) "Particulates" includes both solid and liquid material in particle sizes from 0.1 to 100 μm. Dust, grit, fly ash, and visible smoke particulates larger than 20 μm settle to the gound somwhat quickly. Smaller particles remain suspended much longer and may be dispersed over extremely wide areas. Thus large particulates potentially might cause corrosion problems close to the source (sea salt-spray is a special case), whereas small particulates

can be important factors at great distances from their source, e.g., dust storms, and farming activities in the U.S. Great Plains result in elevated particulate concentrations downwind in the north east.

Particulates vary widely in chemical composition. They generally are classified according to the source:[22] (1) salts from sea spray and salt flats; (2) dusts from agricultural lands; (3) soots from the incineration of agricultural wastes and the burning of fuels; (4) agricultural and industrial dusts. Ninety per cent of airborne particulates originate from natural sources. Very few monitoring stations report the chemical compositions of particulates, but provide only total concentrations. Thus, although the corrosiveness of various particulates may vary widely, there is no way to take account of the differences, because data are not available. Geographical proximity to salt, however, is a notable exception. The corrosivity of salt is well established, but for other particulates, there exist only a few studies[22] which show corrosion to be more severe in industrialized areas with high particulate concentrations. These studies are ambiguous, however, because other corrosive factors are present.

The presence of salt greatly increases corrosion rates for nearly all metals,[7,9] hence the proximity of salt sources will be of much concern. Environments where airborne salt concentrations are high will be high risk environments. When soluble salts, e.g., sodium chloride or ammonium sulfate, are present, corrosion products usually are water soluble and readily removable. Corrosion products which form in the presence of water only, however, usually are weakly soluble, thus not readily removed, and serve a protective function to the underlying metal. In addition, many anions remove primary oxide films or displace oxygen layers which are passivating.[9]

There is a synergistic effect between salt deposits and the atmospheric water content. The deliquescent salts

undergo a phase transformation from dry crystal to a solution droplet when the ambient water vapor pressure exceeds that of a saturated solution of the highest hydrate.[7] The relative humidities at which this transformation occurs for ammonium sulfate, sodium sulfate, sodium chloride, and ammonium nitrate are 80, 86, 75, and 62 per cent, respectively. Thus salt deposits both attract moisture to metal surfaces and provide the electrolyte solution required for corrosion.

(2) Sulfur, another atmospheric pollutant, enters the atmosphere in a variety of forms, including sulfur dioxide, SO , hydrogen sulfide, H_2S, and sulfate salt particulates.[23] About two thirds of all atmospheric sulfur comes from natural sources, mainly as H_2S from bacterial action which later is converted to sulfur dioxide. Estimates of world-wide emissions of sulfur dioxide emitted initially as SO_2, both man-made and natural, show that more than 80% (or 16% of the total in the air at any given time) comes from combustion of sulfur-containing fuels. The smelting of nonferrous metals and petroleum refining account for most of the remaining 20%. The only apparent natural source of sulfur dioxide is a small contribution from volcanoes.

Sulfur dioxide initially is oxidized photochemically to sulfur trioxide, which then combines with water to form sulfuric acid. The primary oxidation process may follow several different paths and can proceed rapidly in polluted atmospheres. In air containing nitrogen dioxide and certain hydrocarbons, sulfur dioxide is oxidized in a photochemical reaction process that produces aerosols containing sulfuric acid. Also, sulfur dioxide can be oxidized in water droplets that contain ammonia, the end product being ammonium sulfate aerosol. Both sulfuric acid and sulfate salts thus formed are removed by precipitation and, to a lesser extent, by gravitational settling.

A large part of the sulfur in the global atmosphere is emitted as hydrogen sulfide produced naturally by decaying organic matter on land and in the oceans and by volcanoes.

Hydrogen sulfide also is emitted by some industrial operations and by catalytic converter-equipped automobiles. Hydrogen sulfide, like sulfur dioxide, is oxidized in the air and eventually converted to sulfur dioxide, sulfuric acid, and sulfate salts.

On a local or regional basis, the mechanisms by which sulfur compounds are removed from the air may produce significant effects. In the early 1960's as the concentration of sulfur compounds in air over Europe began to rise, so did the acidity of precipitation.[24] Both phenomena are attributed to increased use of sulfur-containing fuels.

Many materials, in addition to metals, deteriorate in the presence of atmospheric sulfur in one form or another.[23] Ferrous alloys, in particular, corrode more rapidly in the presence of SO_2, the effect apparently being synergistic with moisture. Hydrogen sulfide attacks copper and silver to form a nonconductive sulfide film, causing electrical contacts to fail.

In the U.S., ambient SO_2 levels have decreased in recent years because of reduced usage of coal and enforcement of "environmental protection" legislation.[25] It appears likely however, that energy considerations will force the U.S. to use more coal, and SO_2 concentrations probably will reach levels no lower than they are today and may even increase.

(3) Hydrocarbons[26] mostly come from natural decomposition of organic matter. Anthropogenic sources are important, however, because they may be highly concentrated geographically where they are not rapidly dispersed. The most notable example is the Los Angeles basin, where the sources are automobile gasoline engines. The fate of the hydrocarbon pollutants involves the reaction with oxides of nitrogen to form photochemical smog, which include a variety of secondary pollutants such as ozone, nitrogen dioxide, and peroxyacetyl nitrates. Hydrocarbons themselves are not

damaging either to metals or protective coatings, but photochemical oxidants are harmful to both.[27]

(4) Nitrogen oxides,[28] NO_x, arise from both natural and anthropogenic sources. The former mainly are organic decomposition, the latter the internal combustion engine. Internal combustion initially yields nitric oxide, NO which by itself is relatively harmless. In the atmosphere, however, NO oxidizes to nitrogen dioxide, NO_2, which is harmful both directly as an irritant and indirectly in the formation of photochemical smog. The chemical reactions occurring in the presence of NO_2, hydrocarbons, and sunlight are complex but yield an atmosphere which is aggressive in the destruction of organic materials such as paint films and protective coatings.

The corrosive effects of NO_x and photochemical oxidants[27,28] probably are indirect. These pollutants may decompose protective finishes on aircraft resulting in premature failure of the coating and exposure of underlying metal. It should be remembered that the nature of local pollutants is relevant to the type of aircraft corrosion problems to be expected. In the industrial eastern U.S., smog containing SO_2 will produce direct metal corrosion to the interior and exposed exterior metal parts of an aircraft, whereas a Los Angeles photochemical-type smog will damage finishes and seals, followed by corrosion of underlying metal.

4. Establishing Environmental Quality Standards For Corrosion

Corrosion accelerates when the following environmental factors are present:

(1) Humidity, rainfall, and solar radiation;

(2) Proximity to the sea or other salt sources; and

(3) Pollutants, mainly sulfur oxides, particulates, photochemical oxidants, and nitrogen dioxide.

The prevalence of these environmental factors varies widely from one geographical location to another and even within

relatively small areas.[29] Moreover, there is much empirical and experimental evidence to show that environmental corrosivity becomes increasingly severe as these factors increase, but at low values, their effects on corrosion are negligible. Thus, it is reasonable to assume the existence of a critical value for each factor, either alone or in combinations, which then could be used to establish environmental severity. The critical value may sharply divide slow and rapid corrosion, such as for iron and aluminum in the presence of SO_2 versus humidity (cf. Rozenfeld[9], pp. 106 and 109). Alternately the variation of damage with the environmental parameter may be gradual, such as the repainting of houses vs. particulate concentration (cf. Stoker and Seager[30], p. 98), thus the critical value is less precisely defined. Where such critical values are known, they can be utilized directly as environmental quality standards.

Unfortunately, such data are nearly nonexistent for all environmental factors except possibly humidity. Most laboratory studies of pollutant effects on corrosion have used concentrations much higher than any found in even the most polluted environments, hence, it is difficult to establish their relevance in real environments. Much effort[22,23,26-28] has been devoted to establishing critical concentration levels with respect to human health, plant, and animal welfare which form the basis of ambient air quality standards. A critical concentration for materials damage, however, may be higher or lower than these. Thus the problem of establishing environmental standards for corrosion is neither simple nor straightforward.

A set of working environmental corrosion standards (WECS) might be developed by consideration of the following:

(1) The range of values for the several ambient parameters, which will establish the limits of environmental exposure, if not the damage to be expected. Such data include maxima, minima, medians, and percentiles for the

measured parameter. Since the actual environments are known to vary in corrosion severity, it follows that critical concentrations for practical use must be within the range of ambient levels, perhaps near the median values or higher.

(2) Ambient air quality standards established by the Environmental Protection Agency are concerned primarily with human health, as noted above. Nevertheless, they do summarize (presumably) careful consideration of all available evidence by a host of scholars and bureaucrats. The values represent the highest levels believed safe for human health and comfort. Although materials may endure higher concentrations or may suffer damage from long term exposure to lower concentrations, these values are a bench mark for damage to something.

(3) Experimental studies which relate corrosion damage with pollutant concentrations and weather variables may provide information for establishing WECS. Several studies, using both real and simulated environments, have been published.

a. Ranges of Ambient Parameters

Within the United States, a number of weather and air quality parameters are measured by several agencies. Weather data are collected by the National Weather Service, the USAF Environmental Technical Applications Center (ETAC), and others, and summaries are available. Weather data most commonly are measured at aerodromes because weather is a critical factor in aircraft operational safety. Air quality data - measurements of a limited number of pollutants - are collected by federal, state, municipal, and private air monitoring stations, and the results are compiled by state agencies and, nationally, by the U.S. Environmental Protection Agency. The purpose of this program is to evaluate air quality primarily in the most densely populated regions of the country. Thus the results are representative of the population distribution rather than geography. They would not necessarily represent the environments to which aircraft

may be exposed and may not be directly relevant to aircraft corrosion. Moreover, many monitoring stations - especially private ones - were established to track specific pollution sources, e.g., certain manufacturing operations, thus their data may reflect highly localized conditions. Despite these limitations, the national data as compiled by EPA are the only data available to assess the range of exposure.

Graedel and Schwartz[31] analyzed ambient atmospheric conditons and quality based on National Weather Service and EPA data. Weather data spanned 30 years from more than 200 measuring sites, and air quality data, mostly from CY 1973, represented as few as 82 to as many as 3760 measuring sites for the several pollutants. Graedel and Schwartz's objective was to determine the range of environmental parameters to which materials are exposed in the U.S. and thus establish "bench marks" for laboratory or field testing. Weather data analyzed by the authors were mean annual temperature and mean annual absolute humidity. Pollutant data were the annual median of hourly averaged continuous data for each measuring site.

We note three results of Graedel and Schwartz for each atmospheric parameter: the median of the 50th percentiles, the median of the 99th percentiles, and the maximum value reported (Table 1). The 50th percentile median represents "average of averages" values reported, whereas the 99th percentile median is the level exceeded at only 1% of all air quality sites. Graedel and Schwartz define the 99th percentile medians as Atmospheric Upper Limit Values, AULV, or "mean high water marks" which may be used for design purposes with the expectation that 99% of the applications will encounter levels below the AULV. The maximum value was the highest mean reported.

The distribution of means as shown by Graedel and Schwartz is more-or-less Poisson-like for all factors except ozone and SO_2. For ozone, a large number of sites reported values below 20 $\mu g/m^3$ and a substantial number were grouped

TABLE 1. RANGES OF ENVIRONMENTAL AMBIENT PARAMETERS, CONTINENTAL U.S.[31]

	50th Percentile	99th Percentile	Maximum Reported
Total Suspended Particulates, $\mu g/m^3$	61	185	500
Sulfur Dioxide, $\mu g/m^3$	43	186	410
Photochemical Oxidants, as ozone, $\mu g/m^3$	36	90	110
Nitrogen Oxides			
as NO, $\mu g/m^3$	25	88	98
as NO_2, $\mu g/m^3$	72	135	150
Temperature, °C	11.8	23.3	25.7
Humidity, absolute, g/m^3	7.1	16.5	18.3

between 30 and 60 $\mu g/m^3$. Nevertheless, the median, 36 $\mu g/m^3$, probably is a valid demarcation between high and low concentration sites. Sulfur dioxide data from 447 monitoring sites, however, was highly skewed toward low values. Indeed, the maximum number of sites reported values at the median and mean value of 43 $\mu g/m^3$, and only 17% of monitoring stations reported means greater than 53 $\mu g/m^3$. Because of this, the significance of the median value for SO_2 is placed in a different light than for the other parameters. This is especially unfortunate because of the peculiar role of SO_2 in corrosion.

Critical levels of atmospheric factors probably are somewhere between the median values and the worst-case maxima or even the AULV's. Clearly the AULV's represent the most hostile environments for individual atmospheric factors in the CONUS, and this worst 10% level would be inappropriate to use in a practical environmental rating scale. To be sure, a design engineer might wish to plan for all but the most hostile environments, as Graedel and Schwartz suggest, but experience shows that this has not been the case in the past. It may be noted that the list of monitoring stations (their Table 2) which exceed the AULV's includes San Bernandino, CA only once (for nitrate ion particulates), whereas Travis, CA and Charleston, SC are not mentioned. All three of these have been shown to be severe environments, the first for paint degradation and the latter two for metallic corrosion.[6,32]*

b. Proximity to the Sea and Other Sources of Salt

Several studies[8,11,13,33,34] have shown that accelerated atmospheric corrosion near the seashore is correlated with airborne sea salt. Establishing a critical distance from the shore, however, is difficult because there is little quantitative information relating corrosion to atmospheric

*The corrosive severity of Travis and Charleston has been attributed primarily to their proximity to salt water, which in turn should indicate high concentration of sea salt. Graedel and Schwartz's list does include several sites near the ocean which exceed their particulate AULV.

salt concentrations, or even relating salt concentrations to distance from the shore. Sea salt is a primary concern because there are few other sources of airborne salt. Coastal salt flats, however, such as those south of Brownsville, TX, have been shown to contribute atmospheric chloride downwind.[35]

The study of atmospheric aerosols[36] has centered mostly on the distribution of particle sizes, rather than the mass of aerosol per unit volume, i.e., micrograms per cubic meter of particulate, as measured at air monitoring stations. The upper limit of aerosol particle size is determined by sedimentation processes. Particles larger than 20 μm radius remain airborne for a short time and are found only in the vicinity of their source. Hence, an atmospheric aerosol by definition consists of particles between 0.1 μm and 20 μm radius. Aerosol particles commonly are classifed as "Aitken" particles, $\leq$ 0.1 μm radius, "large" particles, 0.1 - 1.0 μm radius, and "giant" particles > 1 μm radius in size. Larger particles settle from the air rapidly whereas smaller particles persist in the atmosphere for long times and travel large distances, and serve as condensation points for rainwater precipitation. Consequently, chloride in rainwater is correlated with small particles, whereas direct settling of large particles occurs near the shore. Thus measurements of sodium chloride in rainwater and of atmospheric sodium chloride particulates vs. distance from the sea may suggest values for the critical distance.

(1) Salt in Rainwater

The concentration of sodium chloride in rainwater is high near and over the ocean, but diminishes inland,[35] as would be expected. Concentrations over the sea are 8.0 μg/l, and over land in the central U.S. are 0.1 μg/l.[35] The concentration decreases logarithmically with distance from the sea up to 500 km in the U.S., and is constant at greater distances. In Europe, the concentration decreases logarithmically up to 300 km, but increases slightly beyond that

distance apparently because of the influence of the Baltic Sea.

It is unlikely, however, that chloride in rainwater is relevant to aircraft corrosion. The exterior surfaces of aircraft exposed to rain are protected by paint, whereas most interior surfaces are not exposed to rain. Moreover, the decrease of chloride in rainwater occurs over large distances, whereas the decrease in corrosion damage is quite abrupt.[9,11] Corrosion rates 10 km from the shore are approximately the same as corrosion rates far inland. Consequently, the critical proximity should not be determined from rainwater chloride concentrations.

(2) Particulate Sodium Chloride

Duce *et al.*[37] have measured the concentration of particulate sodium chloride and other ions in the air at various elevations and distances from the sea-shore on Hawaii Island, HI. All measuring sites were downwind of offshore trade winds. Their results show chloride concentrations at all sites varying widely with ambient weather conditions. Their primary interest was the variation of chloride and other ionic components with elevation above sea level, rather than distance from shore. Nevertheless, the results show a consistent, monotonic decrease in chloride concentration with increasing distance from the shore.

The results of Duce *et al.* are reproduced in part in Figure 1. Also included are two additional reported values for giant particle chloride concentrations, one over the ocean and one near the shore in Massachusetts. The over-ocean values should be compared with Junge's summary[36] (p. 162) of salt concentration *vs* wind velocity measurements, which illustrate the wide variability of such data.

Hudson and Stanner[34] found in Nigeria that sodium chloride concentration in the air varies within wide limits and depends strongly on the distance from the shore. The sodium chloride content in the air is about .22 milligrams per cubic meter. The amount of salt that settles out on

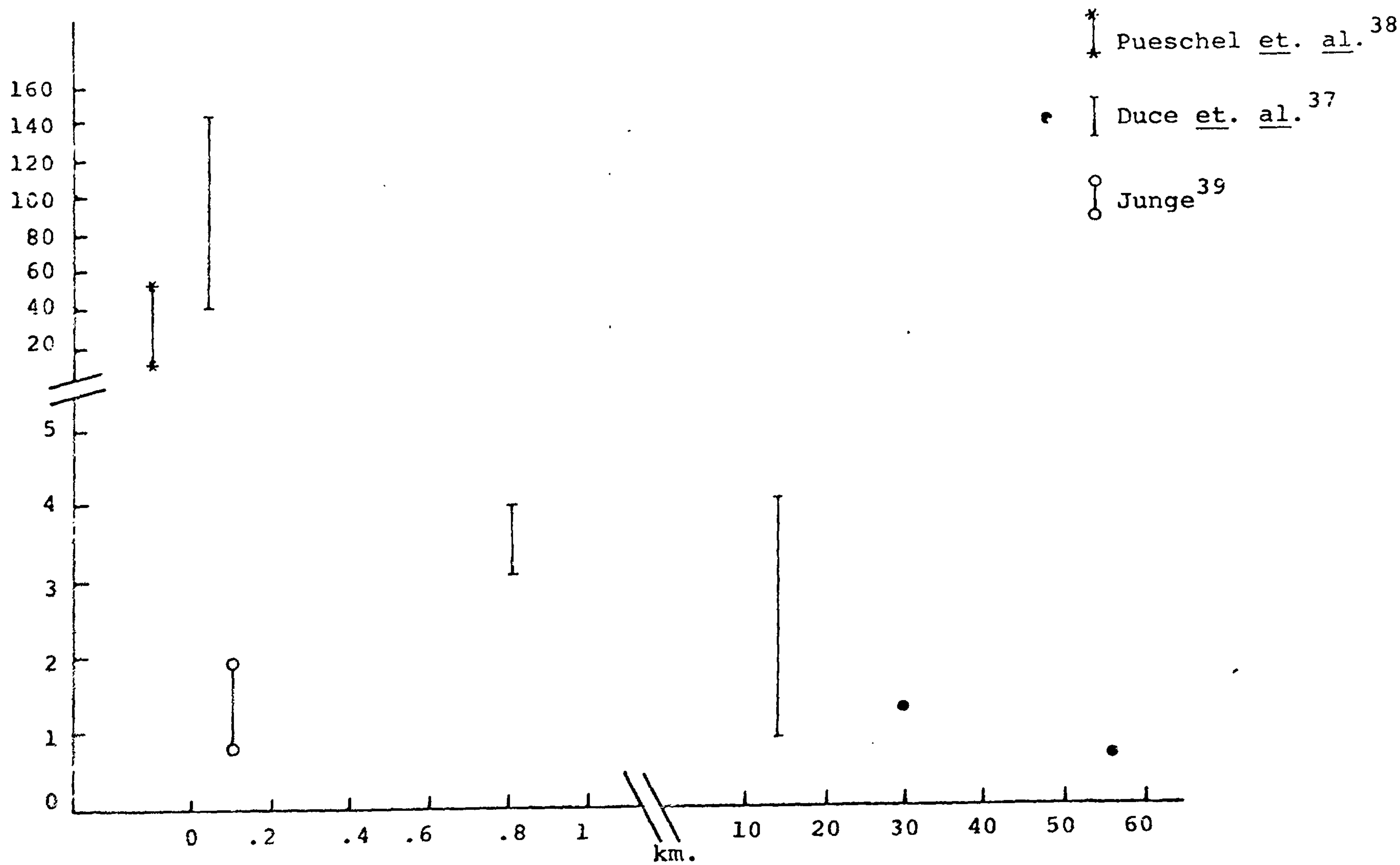


Figure 1. Atmospheric Salt Particle Concentration vs. Distance From Seashore

the surface under these conditions reaches values from 10 to 1000 milligrams per square meter per year. Corrosion tests were conducted at various distances from the shore with simultaneous determination of airborne salt concentration. The relationship between salt deposits and distance from the sea as well as corrosion rates vs. distance from the sea are shown in Figure 2.

Available evidence shows that giant particle chloride concentrations in the atmosphere are reduced by about 1 order of magnitude at a distance of 3/4 km from breaking surf. At distances of about 15 km the concentration reaches a value which remains nearly constant further inland.

Junge[36] (p. 176) has drawn together the available data on giant salt particulates _vs._ distance from sea. Values of 5 $\mu g/m^3$ correspond to near-shore and approach 0.5 $\mu g/m^3$ at distant points inland.

The available data on atmospheric corrosion near marine environments suggests that the decrease in corrosion rate parallels this decrease in giant salt particulates, and "marine atmospheres are aggressive in direct proportion to the concentration of (airborne) NaCl particles" (Rozenfeld[9]).

Most studies suggest a critical distance of less than 1.5 km for sites where strong off-shore winds are not prevalent. Allowing for the variability of weather, however, it seems prudent to extend this to 4.5 km.

c. U. S. National Ambient Air Quality Standards (NAAQS)

The Federal Clean Air Act (Public Law 91-640) directed the Environmental Protection Agency (EPA)

> "to publish proposed national primary and secondary ambient air quality standards based upon air quality criteria [also issued by EPA]. Primary ambient air quality standards define levels of air quality which [the EPA judges] necessary, based on the air quality criteria and allowing an adequate margin of safety, to protect the public health. Secondary ambient air quality standards define levels of air quality which [EPA] judges necessary, based on the air

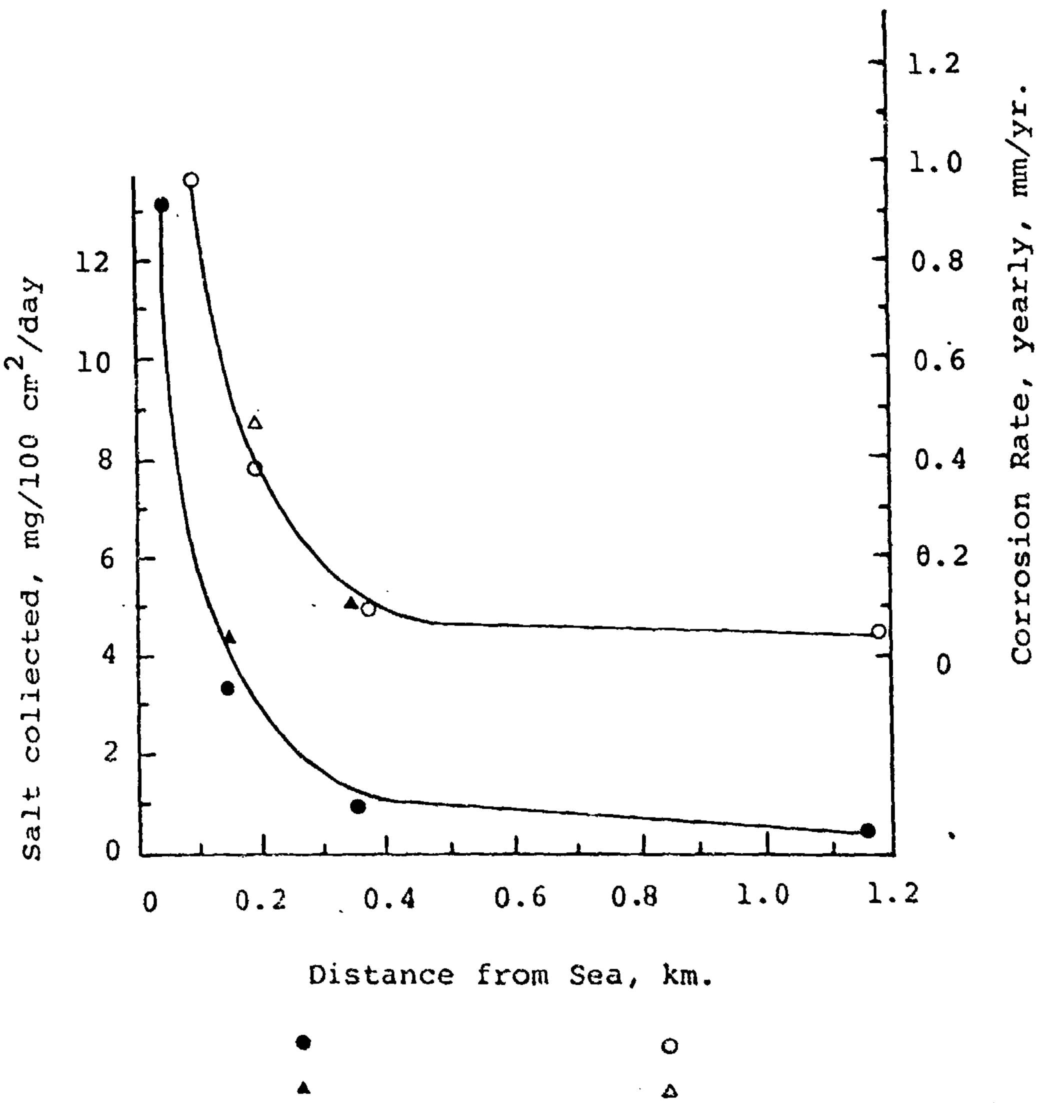


Figure 2. Surface Salt Deposits and Corrosion of Iron vs. Distance From Sea, Nigeria (after Rozenfeld 1972, p. 122)

> quality criteria to protect the public welfare from any known or anticipated adverse effects of an air pollutant."[40]

Air quality criteria published by EPA summarize the scientific knowledge relating pollutant concentrations and their adverse effects. They were issued to assist the development of air quality standards. Air quality criteria merely describe effects that have been observed when the ambient air level of a pollutant has reached or exceeded a specific value for a specific time interval. In developing criteria many factors were considered, including the chemical and physical characteristics of the pollutants, the techniques available for measuring them, exposure time, relative humidity, and other conditions of the environment. The criteria attempted to consider the contribution of all variables to the effect of air pollution on human health, agriculture, materials, visibility, and climate. Air Quality Standards on the other hand legislate pollutant concentrations that the government determines should not be exceeded in a specified geographic area. Primary standards were intended to protect public health, whereas secondary standards were intended to protect public welfare. Public welfare includes effects of pollutants on soil, water, vegetation, materials, animals, weather, visibility, and human comfort. (Materials significantly are not important.) In the case of some pollutants, the primary and secondary standards are the same, whereas for others, notably sulfur oxides and particulates, the secondary standards are lower. These standards are listed in Table 2.

It is difficult to determine how EPA based the NAAQS on the respective Air Quality Criteria.[22,23,26-28] Comments submitted to EPA, subsequent to the first publication of standards, "reflected divergences of opinion among interested and informed persons as to the proper interpretation of available data on the public health and welfare effects of the six pollutants . . . "[41], suggesting that others

TABLE 2. NATIONAL AMBIENT AIR QUALITY STANDARDS[41]

	Primary	Secondary[a]	
Sulfur dioxide	80	60	$\mu g/m^3$, annual arithmetic mean
	365	260[b]	$\mu g/m^3$, 24-hour maximum
		1300	$\mu g/m^3$, 3-hour maximum
Particulate matter	75	60	$\mu g/m^3$, annual geometric mean
	260	150[c]	$\mu g/m^3$, 24-hour maximum
Carbon monoxide	10	10	mg/m^3, 8-hour maximum
	40	40	mg/m^3, 1-hour maximum
Photochemical oxidants	160	160	$\mu g/m^3$, 1-hour maximum
Hydrocarbons	160	160	$\mu g/m^3$, 6 to 9 AM maximum
Nitrogendioxide	100	100	$\mu g/m^3$, annual arithmetic mean

[a]Maximum values are not to be exceeded more than once per year.

[b]". . . as a guide to be used in assessing implementation plans to achieve the annual standard."

[c]". . . as a guide to be used in assessing implementation plans to achieve the 24-hour standard."

could not follow the logic used in developing standards. "In reviewing the proposed standards, the Environmental Protection Agency limited its consideration to comments concerning the validity of the scientific basis of the standards.

"Current scientific knowledge of the health and welfare hazards of these air pollutants is imperfect."[41] Indeed! The Clean Air Act, however, required the promulgation of standards by a specific date. Accordingly EPA had no choice but to base these standards on the available data. That data as quoted in the Air Quality Criteria are sketchy and contradictory. Using the available scientific evidence, any standard value could be established within a wide range.

In responding to comments on the initial standards, EPA did state the basis for setting several of the standards. The standard for carbon monoxide

> "was based on evidence that low levels of carboxy-hemoglobin in human blood may be associated with impairment of ability to discriminate time intervals . . . In the comments, serious questions were raised about the soundness of this evidence [and] extensive consideration was given to this matter. The conclusions reached were that the evidence regarding impaired time-interval discrimination have not been refuted and that a less restrictive national standard for carbon monoxide would therefore not provide the margin of safety which may be needed to protect the health of persons especially sensitive to the effects of elevated carboxyhemoglobin levels. The only change made in the national standards for carbon monoxide was a modification of the 1-hour value. The revised standard affords protection from the same low levels of blood carboxyhemoglobin as a result of short-term exposure. The national standards for carbon monoxide, as set forth below, are intended to protect against the occurrence of carboxyhemoglobin levels above 2%.
>
> "National standards for photochemical oxidants have also been revised. The revised national primary standard of 160 micrograms per cubic meter is based on evidence of increased frequency of asthma attacks in some asthmatic subjects on days when estimated hourly average concentration of photochemical oxidant reached 200 micrograms

per cubic meter. A number of comments raised serious questions about the validity of data used to suggest impairment of athletic performance at lower oxidant concentrations. The revised primary standard includes a margin of safety which is substantially below the most likely threshold level suggested by this data.

"National standards for hydrocarbons have been revised to make these standards consistent with the above modifications of the national standard for photochemical oxidants. Hydrocarbons are a precursor of photochemical oxidants. The sole purpose of providing a hydrocarbon standard is to control photochemical oxidants. Accordingly the above described revision of the national standards for photochemical oxidants necessitated a corresponding revision of the hydrocarbon standards.

"National standards for nitrogen dioxide have been revised to eliminate the proposed 24-hour average value. No adverse effects on public welfare have been associated with short term exposure to nitrogen dioxide at levels which have been observed to occur in the ambient air. Attainment of the annual average will, in the judgment of the EPA, provide an adequate safety margin for the protection of public health and will protect against known and anticipated adverse effects on public welfare."

We conclude that the NAAQS are of little relevance to corrosion in aircraft.

d. Experimental Studies Relating Corrosion to Environment

Several studies have attempted to develop quantitative relations between corrosion and environmental parameters. These will be discussed as possible indications of critical values.

Upham[42] conducted atmospheric exposure studies at established air monitoring sites in St. Louis and Chicago. His results showed approximately linear relationships between corrosion rates and SO_2, TSP, and surface sulfation rates for low-carbon, low-copper mild steel panels. Mansfield[43,44] has extended this work to a wider variety of

materials at St. Louis sites, but analysis of the results is not complete.

Guttman[21] conducted a long term exposure program using zinc at a single site and compared the results with environmental conditions. He showed that the most important factors are time of wetness and the atmospheric concentration of SO_2, and, further, that the time of wetness is a consequence of ambient relative humidity. He found temperature not to be important. Using a curve-fitting technique, Guttman obtained an empirical equation

$$y = 0.00546\, A^{0.815}\ (B + 0.0289),$$

where

y = corrosion loss, mg/3x5-in panel,
A = time of wetness, hr., and
B = SO_2 concentration during the time panels were wet, ppm.

This equation suggests a linear dependence of corrosion damage on SO_2 concentration, which would imply that there is no critical concentration. Guttman did not relate time of wetness to weather parameters, thus it doesn't help this study.

Haynie and Upham[45], in an extension of Guttman's work with zinc, assumed a linear dependence of corrosion on mean relative humidity and mean SO_2 concentration. Zinc specimens were exposed at a number of U.S. Public Health Service Continuous Air Monitoring Program (CAMP) sites. Corrosion damage to the samples was compared with CAMP pollutant data and weather data from the nearest weather station. Statistical analysis yielded

$$y = 0.00104\ (RH - 49.2)\ SO_2 - 0.00664\ (RH - 76.5)$$

where

y = zinc corrosion rate, μm/yr.,
RH = mean relative humidity, %, and
SO_2 = mean SO_2 concentration, μg/m^3.

This equation suggests that zinc will not be wet below RH of 76.5% in the absence of SO_2 and, furthermore, increasing humidity above that point inhibits corrosion. Haynie and Upham view this as consistent with the formation of a protective carbonate film. In the presence of SO_2, however, their equation indicates a linear dependence on the product of RH with SO_2 and a linear dependence on SO_2. Again, critical values of each parameter are not indicated.

Equations such as these can be used to predict the useful life of galvanized iron products which are scrapped when the zinc coating is perforated. Haynie and Upham have made such predictions for various environments and their results compare well with experience.

Haynie and Upham[46] conducted a more extensive study of the corrosion of enameling steel and atmospheric factors. Specimens were exposed at 57 sites of the National Air Sampling Network (NASN) coordinated by the EPA. Weight loss data were obtained at one year and two years and were correlated with mean weather data (RH and temperature) and pollutant concentrations (SO_2, TSP, sulfate ion $SO_4^{=}$, and nitrate ion NO_3^{-}). Correlation analysis identified the variable set which was used in multiple regression analysis. Haynie and Upham found that corrosion of steel is a function primarily of $SO_4^{=}$, NO_3^{-}, RH, and time. Temperature, TSP, and SO_2 appeared to be insignificant. Because of an observed covariance between $SO_4^{=}$, and SO_2, together with many other studies which had shown a relation between corrosion and SO_2, Haynie and Upham suggested that $SO_4^{=}$ may be merely a "proxy" variable for SO_2. When $SO_4^{=}$ data were excluded from their analyses, the empirical fit was nearly as good with SO_2 as with $SO_4^{=}$.

The relation between corrosion for this steel and the environmental factors considered was best expressed as

$$\text{corr.} = 183.5 \sqrt{t} \exp(0.0642\ \text{Sul} - 163.2/\text{RH}),$$

where

t = time, yr.,

Sul = mean concentration $SO_4^=$ or SO_2, $\mu g/m^3$, and

RH = relative humidity, per cent.

By transposing the time factor to the left hand side, Haynie and Upham show the dependence of "pseudocorrosion rate", corr./$\sqrt{t}$, on SO_2 concentration and relative humidity.

Environments where RH and SO_2 are high should be more corrosive and maintenance to equipment will be required more frequently. The frequency of a given maintenance operation would be inversely proportional to the time required for corrosion to reach a specified depth. Thus a crude estimate of the ratio of maintenance frequency in a SO_2 polluted environment to that in a cleaner environment is given by Haynie and Upham as

$$MFR = \exp(.006\ SO_2),$$

or

$$MFR = \exp[.006\ (SO_{2a} - SO_{2b})]\ ,$$

where MFR - maintenance frequency ratio, and a, b refer to two different environments.

Haynie, Spence, and Upham[47] have studied the corrosion of weathering steel and galvanized steel in a laboratory chamber with various combinations of humidity, radiation, and pollutants. Experiments were conducted in atmospheres containing SO_2, NO_2, O_3, and water vapor, each at two different concentrations as listed in Table 3, and the results were compared with corrosion rates in clean humid air. This two-level factorial arrangement was selected to identify environmental factors statistically. It may be noted from Table 3 that the three "low" pollutant concentrations are essentially equal to the primary NAAQS values, and considerably higher than the 50th percentiles of Graedel and Schwartz[31]. Absolute humidities are very high compared with the ambient 50th percentiles. The "high" values of the several factors are many times greater than the extreme values of the U.S.

TABLE 3. ENVIRONMENTAL FACTORS AND LEVELS USED BY HAYNIE, SPENCE, AND UPHAM[47]

Environmental Factors	Level Low	Level High
Sulfur dioxide, $\mu g/m^3$	79	1310
Nitrogen dioxide, $\mu g/m^3$	94	940
Ozone, $\mu g/m^3$	157	980
Absolute humidity, g/m^3	19.8	35.7
RH (at 35°C)	50	90

Analyzing the results, Haynie et. al. conclude that only SO_2 humidity, and their interaction are significant factors in the corrosion of weathering steel. For galvanized steel, only the direct effects of the two were of importance. Thus, they view NO_2 and O_3 as having little or no effect on the corrosion of these alloys.

Their corrosion rate results, reproduced in part in Table 4 however, suggest otherwise. (We must admit we do not have access to their complete analysis.) Corrosion rates in the atmospheres containing the three pollutants and moisture are significantly increased over those in humid air alone. Raising each pollutant to the "high" value one at a time again results in strikingly increased corrosion rates, the largest increase being for SO_2. From these data, it appears that NO_2 and O_3 do accelerate corrosion rates, although not as much as SO_2.

e. Working Environmental Corrosion Standards (WECS)

After considering the existing literature on materials degradation and environmental factors, we conclude that there are no firm guidelines for setting WECS, with the exception of humidity. Metallic corrosion is definitely accelerated in the presence of SO_2 and high humidity, and probably accelerated by NO_2, oxidants, and many particulates. Organic protective finishes are deteriorated by solar radiation, oxidants, some particulates, and possibly by NO_x and SO_2. Published research does not tell us, however, at what level these factors become significantly damaging.

Accordingly, we adopt the view that critical values lie within the range of ambient values, because accelerated corrosion has been observed in existing environments. We adopt two sets of WECS based on the analysis of Graedel and Schwartz[71]. The first set are their 50th percentile values and the second set are the 50th percentile values plus 20 percent of the difference between the 99th and 50th percentiles. These are listed in Table 5. The values for proximity to salt or sea are based on the analysis presented

TABLE 4. CORROSION RATES (μm/YEAR) OF WEATHERING STEEL IN DESIGNATED CONTROLLED ATMOSPHERES (AFTER HAYNIE, SPENCE, AND UPHAM[47])

Low RH Only	Low RH, O_3, NO_2, and SO_2	High, Others Low	
28	84	RH	147
		O_3	123
		NO_2	162
		SO_2	371

High RH Only	High RH, low O_3, NO_2, and SO_2	High RH, High , Others Low	
86	147	O_3	230
		NO_2	178
		SO_2	656

TABLE 5. WORKING ENVIRONMENTAL CORROSION STANDARDS (WECS)

	Annual Mean I	Annual Mean II	Secondary
Suspended Particulates, $\mu g/m^3$	61	86	
Sulfur dioxide, $\mu g/m^3$	43	72	
Ozone, $\mu g/m^3$	36	47	79
Nitrogen dioxide, $\mu g/m^3$	64	78	122
Absolute humidity,* g/m^3	7.1	9.0	
Proximity to sea or salt source, km.	4.5	2	
Solar radiation, July (Langleys)	600	650	
Rainfall, cm. total	125	150	

*Absolute humidity is the product of relative humidity and the mass of water in one cubic meter of water-saturated air[48] at a given temperature.

earlier of published data. The solar radiation values are based on the mean (July) values for the continental U.S.

These WECS have been used in the Corrosion Severity Index Algorithms (described in a subsequent section) and the results compared with experimental environmental ratings. The agreement is sufficiently good that the values of Table 5 together with the Algorithms may be used to compute accurate relative environmental severity for corrosion in aircraft.

5. Corrosion Severity Algorithms

a. The 1971 Corrosion Factor Equation

Evolution of the 1971 CF equation spanned several years. Many factors were considered (Table 6) which might be used to derive a three-step rating scale (mild, moderate, severe).

> "Parameter limits were established by relating 10-20 years of corrosion data for nonferrous metals from ASTM to the appropriate parameter. The air pollutant data was obtained from the Department of HEW and is representative of five year averages. We also used six months of air frame corrosion data...The most weight in the rating is given to relative humidity..."[49]

Other parameters considered were general climate rating, prevailing wind, water content of the air, number of days with dense fog, the amount of precipitation, the number of thunderstorms, and the number of cloudy days. Foggy, wet days were considered harmful, but heavy thunderstorms in arid areas as beneficial.

The 1971 CF equation, however, did not include pollutant data, probably because the information available at that time was inadequate or unreliable.

The 1971 CF equation is

$$CF = [2(RH) + 2(PS) + DP + NC + HR + WV] /6,$$

where the several factors are related to relative humidity, proximity to the sea, dew point, no ceiling (sunshine), heavy rain, and wind velocity, respectively. Each factor is an integer (1, 2, or 3) representing a range of values for the relevant parameters; they do not represent the parameters directly. These value ranges are detailed in Table 7.

Interim numerical classifications were derived from the CF equation from nine years of climate data (1961-1970) compiled by USAF Environmental Technical Application Center (ETAC).[50] Numerical indices were published for 39 SAC airbases in 1972, and for 95 USAF and 27 ANG airbases in 1973. A complete list was distributed in 1974 under the title "PACER LIME Interim Corrosion Severity Classification." These values are reproduced in Appendix A.

TABLE 6. ENVIRONMENTAL FACTORS CONSIDERED IN DEVELOPING A CORROSION SEVERITY INDEX ALGORITHM

Moisture

- Relative humidity
- Water content of air
- Thunderstorms
- Amount of precipitation
- Fog

Airborne contaminants

- Proximity to sea (salt)
- $SO_4^{=}$, SO_2
- Suspended particulates (hygroscopic)

Climate (other than moisture)

- Cloud cover
- Wind direction, speed

Local geographical factors

- Soil type
- Topography (plains, mountains, swamp)
- Nearest city, its size, direction

TABLE 7. THE CORROSION FACTOR EQUATION AND PARAMETER RANGES

$CF = [2(RH) + 2(PS) + DP + NC + HR + WV]/6$

CF = Corrosion Factor:

Value	Rating
1.00-2.00	Severe
2.01-2.85	Moderate
2.85-3.75	Mild

	Average Rel. Humidity RH	Distance PS	Days Per Month DP
	RH is the average relative humidity parameter under all weather conditions.	PS is the proximity to the sea parameter.	DP is the dew point parameter, determined by the number of days per month when the temperature is within 4°F of the dew point for three or more consecutive hours.
1	100-70.01%	5 miles or less	more than 10
2	70.00-50.00	5 to 80 miles	more than 5 but less than 10
3	49.99-0	greater than 80 miles	fewer than 5

	Days Per Month NC	Days Per Month HR	Average Wind Velocity WV
	NC is the no ceiling (sunshine) value determined by the number of days per month with six or more hours of no ceiling.	HR is the moderate to heavy precipitation parameter. Moderate precipitation is 0.11 to 0.3 inches of rain in the preceding hour or 0.01 to 0.03 inches in a 6 minute interval.	WV is the average wind velocity parameter.
1	5 or less	0-1.50	1-1.50 mph
2	5.10-12	1.51-6	1.51-6.00
3	more than 12	6.01 or more	6.01 or more

TABLE 8

RANGE OF COMPUTED PACER LIME CORROSION SEVERITY INDEX

Scale	CSI	Classification	Number in Atmospheric Exposure Test
		3.75	
0	3.33		1
1	3.17	mild	
2	3.00		1
		2.86	
		2.85	
3	2.83		3
4	2.67		1
5	2.50	moderate	3
6	2.33		
7	2.17		
		2.01	
8	2.00	2.00	
9	1.83	severe	2
10	1.67		
		1.00	

The CF values were calculated to two decimal places. Since the independent parameters in the equation are integers, however, the CF equation is in fact an integral scale of seventeen steps. The computed list for actual airbase environments includes only eleven steps. Thus the CSI scale could be represented by a zero to ten scale (CF Table 8), but was compressed to a three-step scale:

CF	=	1.00 to 2.00*	Severe
		2.01 to 2.85	Moderate
		2.86 to 3.75*	Mild.

The CF equation ranks the following factors as harmful:

(a) Relative humidity above 70%;

(b) location within five miles of the sea, without reference to wind direction;

(c) temperature within 4°F of dew point for three or more consecutive hours and more than ten days per month;

(d) five days or fewer per month with six or more hours of no ceiling (sunshine), without reference to temperature;

(e) five days or fewer per month with moderate or heavy rain;

(f) wind velocity less than 1.5 mph.

---

*The minimum and maximum values the CF equation can yield are 1.33 and 4.00, which correspond to the following climates:

1.33--High humidity, the temperature is frequently close to the dew point, location near the sea, winds nearly calm, generally cloudy and overcast, but heavy rainfalls are infrequent, and

4.00--Arid, windy, skies clear, more than 80 miles from the sea, but heavy rainfalls are frequent.

Thus heavy rains are considered beneficial because of washing effects, and high winds and sunny days are beneficial because of their drying effects.

b. Comments on the CF Equation

The manner in which humidity, dew point, and rainfall data are included in the CSI is contradictory, since, as discussed earlier, all three contribute moisture and promote corrosion in aircraft. All moisture sources should be considered harmful to aircraft, particularly rainfall since it frequently finds its way into areas where it should not be. Dew point and relative humidity are related; temperatures at or near the dew point result in condensation on aircraft surfaces, and moisture will condense from humid air on cold aircraft surfaces.

Proximity to the sea considers distances up to 80 miles as harmful, but significant airborne salt concentrations are found only quite near the shore in normal weather, and the concentration decreases rapidly with distance from the sea up to about 15 km and is constant beyond that point. Heavy storms can carry salt considerably farther inland, but these are relatively infrequent, so that aircraft washing and corrosion treatment schedules could be changed temporarily following such an event. Thus, emphasis on PS can be reduced, considering it harmful only if aircraft are normally within 1 to 4 km of sea water. At greater distances it may be neglected.

It is difficult to assess the value of sunshine as in the use of a no ceiling, NC, factor. It is true that direct sunshine accelerates moisture evaporation, but its efficacy also depends strongly on temperature. Further, intense solar radiation is highly damaging to protective finishes, so much that solar damage vs the benefits of solar drying may be an unequal tradeoff.

The value of wind as a drying agent also must be weighed against the harm it may cause by transporting pollutants to aircraft. In the CF equation, wind is beneficial because of its moisture removal effect. Only the aircraft exterior is accessible to such wind effects, whose surfaces are protected by paint. Moisture inside the aircraft, where it is most

damaging, would be affected little by wind.

Wind could have a damaging abrasive effect through the action of airborne sand. Wind velocities are negligible, however, compared with takeoff and landing speeds, the damaging effects of which are visible on the leading surfaces and obviously are a more serious corrosion threat than surface winds.

In summary, the CF equation centers almost entirely on the atmospheric conditions which produce or remove moisture. The only other corrosion-related factor is sea salt, included indirectly via proximity to the sea. In addition to the contradictory use of rainfall, moisture factors are over-emphasized in some cases and, in others, included in a form that is not related clearly to corrosion. As a moisture-plus-sea-salt parameter, the CF equation was a reasonable first step toward the development of a corrosion severity rating system. The next steps would have included:

--comparing the CF results with maintenance experience--both field and depot--via AFM 66-1 data;

--comparing the CF results with atmospheric test data which, as noted, have not been available in usable form until now;

--modifying the equation to include the now-available pollutant data.

c. Environmental Severity Algorithms for Aircraft Corrosion

We propose an alternative set of algorithms, based on locally-measured environmental factors and which rely in part on maintenance experience as contained in AFM 66-1 records. A particular feature of this approach is that the authority to set maintenance intervals is left in the hands of local management. These decisions would be based on locally measured meteorologic and pollutant conditions and would be subject to changes dictated by local experience. Effective use of the decision-making tools could be monitored easily by MAJCOM and AFLC analysis of MDCS data.

(1) Corrosion Maintenance in Aircraft

Excluding housekeeping, corrosion maintenance involves

(1) washing of exterior surfaces,

(2) repair or replacement of protective coatings and sealants, and

(3) treatment and repair of corroded components.

Environmental elements which corrode metal are not necessarily the same as those which deteriorate paint and sealants. Humidity, SO_2, and certain other contaminants corrode bare metal,[21] whereas paint films deteriorate under the action of sunlight, photochemical oxidants, and a few other pollutants.[22, 26-28] Soil deposits also are harmful to paint films, are related to suspended particulates, and their damaging effects are accelerated by contaminants such as SO_2.[51]

Consequently, no single algorithm can classify an environment with respect to all three corrosion problems. Instead three decision algorithms are required to determine intervals for:

- aircraft washing
- complete repainting, and
- corrosion inspection/maintenance.

Each algorithm would assess the level of local contaminants and, via a decision-map, lead to recommended intervals for each maintenance cycle.

(2) Aircraft Washing

Aircraft are washed both to maintain appearance and to remove soil deposits which may damage the paint. There are several sources of soil: engine exhausts, fuels, and lubricants; airborne particulates; and the workers' shoesoles during maintenance and servicing operations. Soil deposits will attract and retain moisture from humid air and gaseous pollutants, particularly SO_2. Thus, the damaging effects of soil are compounded by high humidity and pollutant concentrations. It is not likely that surface soils accelerate paint degradation by sunlight or gaseous oxidants, but there is no evidence to support this view. Thus, aircraft washing intervals selected to protect

the paint and exposed metal should be related to particulates (and proximity to the sea), SO_2, (possibly) NO_2, and humidity. It is likely that cosmetic purposes will be served by the same intervals. USAF recommended washing intervals, for several years, have been 45, 60, and 90 days, depending on local conditions. At many airbases, where indoor washing facilities are not available and winters are severe, even the 90 day wash interval is impractical. Other airbases plan 30-day intervals. Practical washing intervals, which are consistent both with environmental risk factors and rigorous climates, are 30, 60, and 120 days. We designate these as A, B, and C, respectively.

The Washing Algorithm (Figure 3) first determines if the distance to the sea is less than the WECS distance. If it is, washing interval A is recommended; if not, particulate concentrations are compared with WECS. If the ambient level exceeds the standard, then the ambient SO_2 concentration is checked. If SO_2 is higher than WECS, interval A is recommended; if lower, interval B.

If particulates are below the standard, SO_2 concentration again is queried: If high, interval B is recommended; if low, moisture factors are considered. High moisture values--either RH or rainfall greater than WECS--lead to interval B recommendation; low values yield interval C.

(3) Painting

Aircraft are painted primarily to protect metal surfaces, although operational and cosmetic factors are significant. Protective finish maintenance is effected at three levels: (a) minor touchup; (b) major touchup; and (c) complete strip-repaint. Minor and major touchup are effected at field or intermediate level maintenance, whereas complete repaint is authorized only at depot-level for large aircraft.[52] Minor touchup is accomplished to repair ablation and similar damage. Major touchup is applied to fasteners, runway-damaged lower surfaces, and solar-damaged upper surfaces. The need for touchup painting must be determined at field-level inspections: an environment-based algorithm should not be used. The following

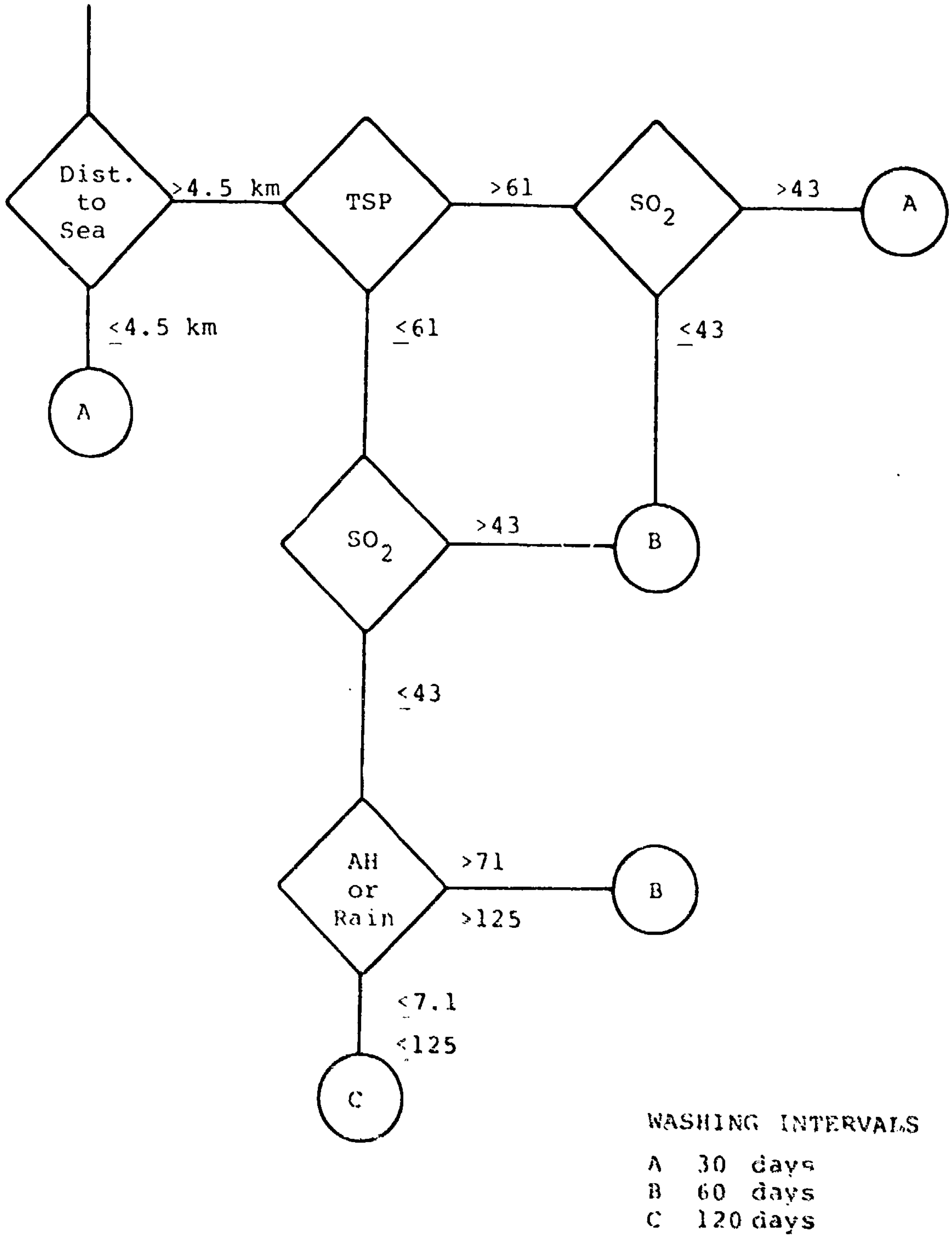


Figure 3. Aircraft Washing Interval Algorithm. Working Environmental Corrosion Standards I (see Table 5) Are Used. Units For TSP, And SO_2 Are $\mu g/m^3$, For AH g/m^3, And For Rainfall, Annual Total cm.

paint-interval algorithm refers to complete strip/repaint maintenance.

As before, three intervals, A, B, and C, are recommended. Paint systems currently in use--epoxy or polysulfide primers and polyurethane finish coat--should provide a service life of 10+ years in the mildest environments.[53] Consequently, the A, B, and C intervals may be equated to 36, 72, and 120 months, respectively. These intervals may not correspond to the PDM intervals for a particular aircraft system. For example, C-141A aircraft currently are on a 42 month cycle, and B-52's are on 48 months. Consequently, repaint schedules should be coordinated with the PDM cycle established for each aircraft fleet/force by the appropriate Maintenance Requirements Review Board. If 120 months is the maximum expected service life for the paint finish, and the PDM interval is y months, then y should be compared with the intervals recommended by the Repaint Algorithm, i.e., 36, 72, or 120 months. The interval closest to the PDM interval should be selected.

Environmental factors which deteriorate paint are, in order of severity, solar radiation, oxidants, and sulfur dioxide absorbed on soil deposits. Soil deposits themselves might be included, but there is insufficient information to relate repaint schedules to the nature of the soils. Thus, only sunlight, oxidants, and SO_2 are considered. The repaint algorithm (Figure 4) compares the solar radiation level, ozone, and sulfur dioxide concentrations with the WECS values. High values for all three result in the A interval recommendation, whereas low values for all three lead to the C interval. Various combinations of high values lead to the B interval.

(4) Corrosion Damage

The Corrosion Damage algorithm (CDA) is of a different nature than those for washing and repainting, which recommend maintenance intervals appropriate to the environment. Although CDA might be used in this same way, such use is unlikely. Corrosion repairs routinely are effected simultaneously with phased and isochronal maintenance efforts, and it would be

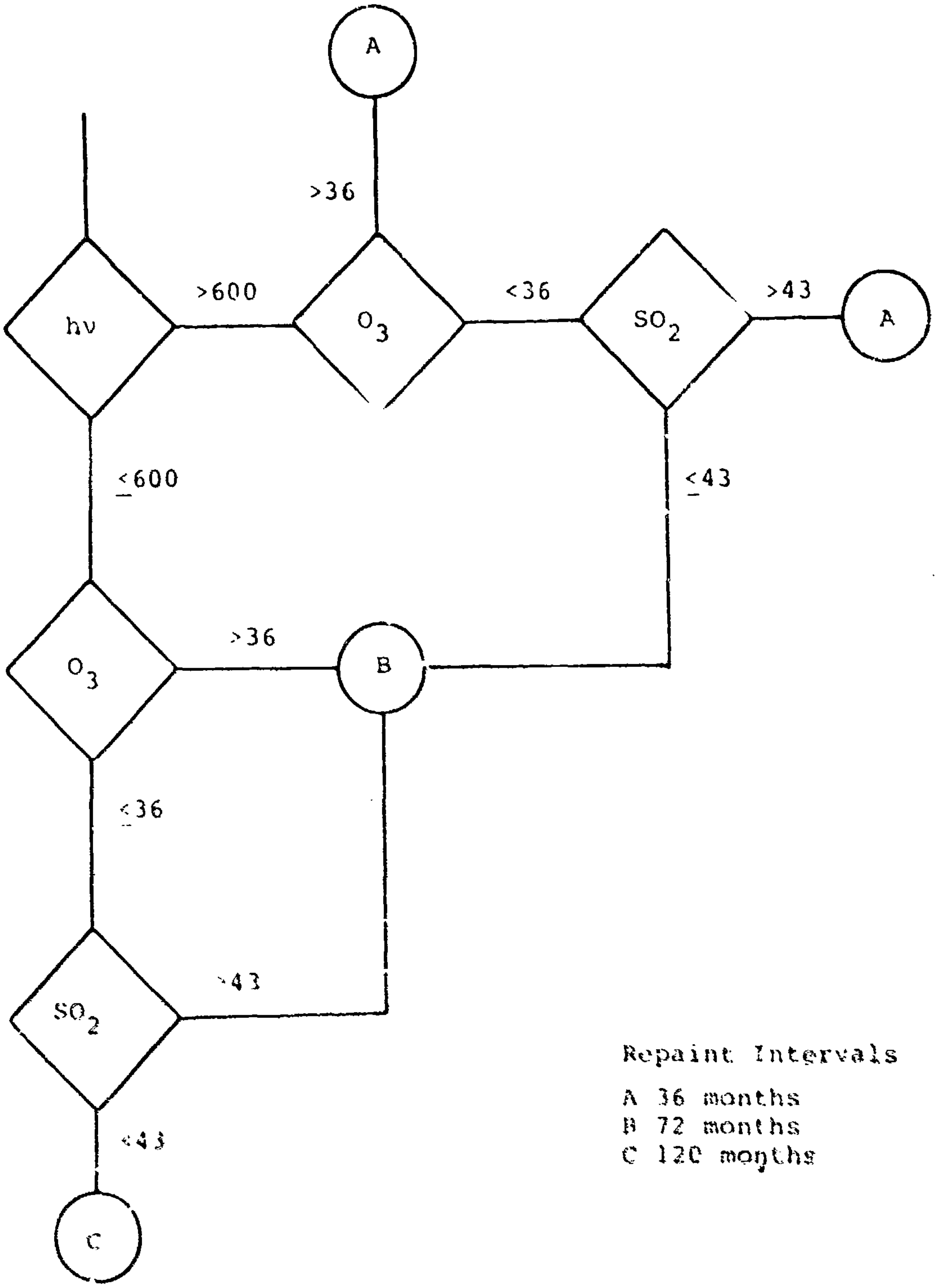


Figure 4. Aircraft Complete Repaint Interval Algorithm. Working Environmental Corrosion Standard I (see Table 5) Are Used. Units For radiation, hν, Are Langleys (July), For Ozone And SO_2, $\mu g/m^3$.

both undesirable and difficult to impact their scheduling.

Accordingly, the CDA is intended as a guide for anticipating the extent of corrosion damage and for planning the personnel complement and time required to effect their repairs. The guidelines at this point are of a general nature. Eventually they should be incorporated into the Reliability Centered Maintenance phase schedules for specific aircraft systems.

The Algorithm (Figure 5) considers first distance to salt water (or slat flats), leading either to the very severe (AA) rating or a consideration of moisture factors. After moisture factors, pollutant concentrations are compared with WECS either for SO_2, TSP, or O_3. High values for any one of the three pollutants together with a high moisture factor leads to the A rating, but if all are low, together with high moisture factor, the severe (B) rating results. Low moisture factors with a high pollutant value result in the moderate (B) rating, whereas if all are low, rating (C) results.

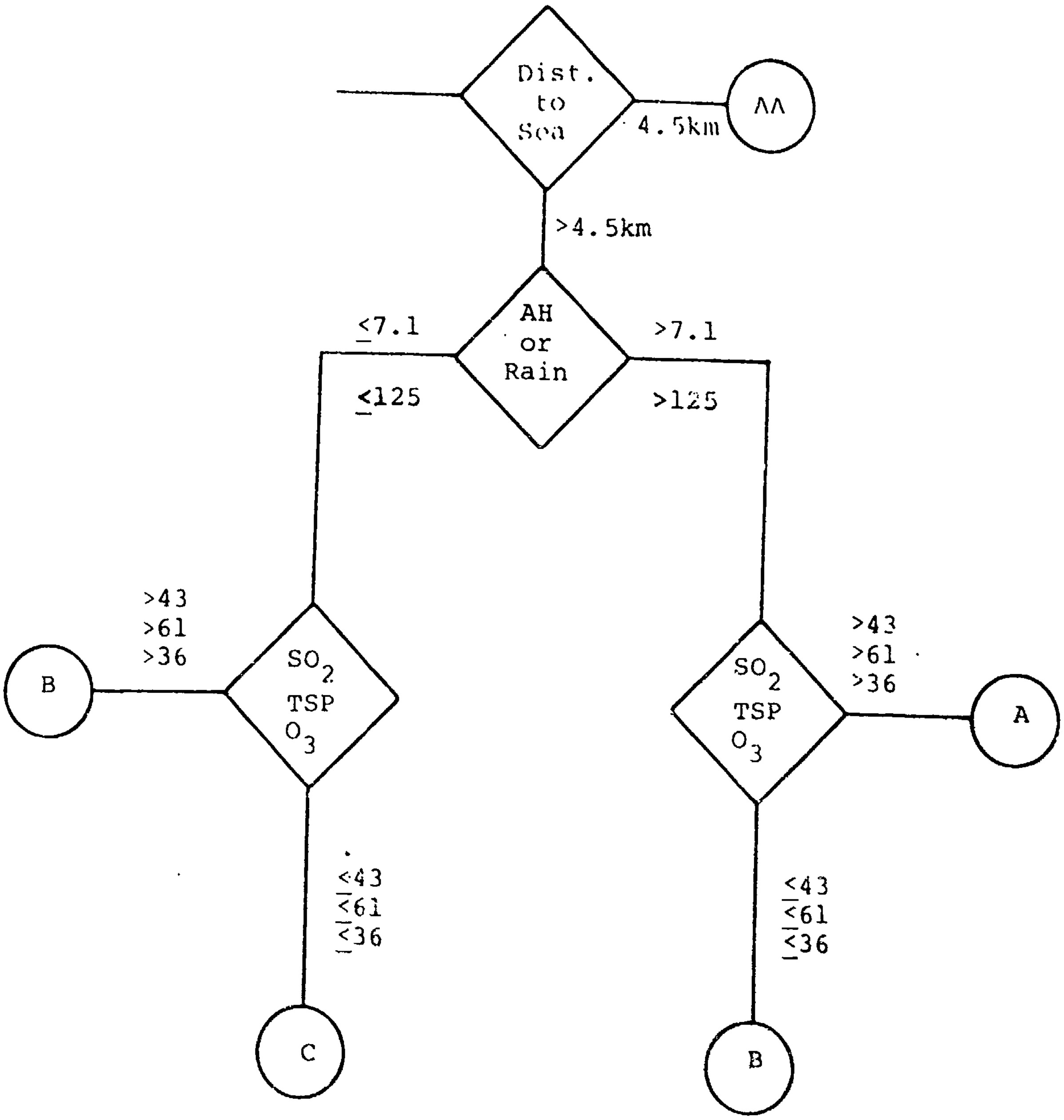
(5) Use of Environmental Algorithms

The above algorithms are readily compared with the appropriate local environmental parameters to yield corrosion maintenance ratings; the use of a computer obviously is not necessary. The algorithms could be used in modified form within the base-level computer system and, with appropriate automatic data input, can provide monthly revisions for maintenance needs recommendations.

To complete this study, it was necessary to develop ratings for a substantial number of airbases. Since the task would be more easily performed by computer, the algorithms have been programmed for such use. The relevant programs together with the necessary documentation, are included in Appendix 2.

(6) Environmental Applications

Environmental Severity Algorithms have been used to establish preliminary ratings for most airbases of interest to USAF. These ratings are listed in Appendix 3. These ratings are based essentially on comparisons of the Working Environmental



Expected Corrosion Damage

AA very severe
A severe
B moderate
C mild

Figure 5. Aircraft Corrosion Damage Algorithm. Working Environmental Standard I (see Table 5) Are Used. Units For RH And 7.1 g/m^3, For Rainfall, Total Annual cm, For SO_2, O_3, And TSP, μg/m^3.

Corrosion Standards with local geographical and environmental data. Slight modifications to the algorithms were necessary in order to use the available data format, but the results are not significantly affected. The ratings published herein are based on the most complete data available to us. No responsibility is assumed for the accuracy of the data, particularly with respect to its relevance to a specific airbase, since the monitoring site may have been located at some distance from the airbase in question. If more accurate and reliable data should become available, they may be used to compute more appropriate ratings.

These algorithms rate environments for maintenance purposes under the assumption that aircraft are parked outdoors and are exposed to all risk factors. Wherever these conditions are different, appropriate consideration should be given. For example, hangared aircraft are exposed to minimal solar damage and rainfall, consequently the ambient solar radiation level and rainfall are not relevant.

(7) Environmental Data

The following environmental data were collected for USAF, AFRES, and ANG airbases, from the sources indicated.

(1) Mean annual relative humidity, mean annual temperature, mean annual rainfall. Source: USAF Environmental Technical Applications Center, "Worldwide Airfield Climatic Data," Vols. I-VIII, 1970.[54]

(2) Mean solar radiation for July. Source: Baldwin, J. L., "Climates of the United States," U.S. Department of Commerce, Washington, D.C., 1973.[55]

(3) Ambient concentrations of SO_2 particulates, NO_2, and O_3. Source: U.S. Environmental Protection Agency, "Air Quality Data--1976 Annual Statistics," March 1978, EPA-450/2-78-009.[56]

(4) Distance to salt water or other salt source and prevalent wind direction with respect to nearest urban/industrial area.
Source: U.S. Department of Commerce," Sectional Aeronautical Charts," Washington, D.C., 1979.[57]

Additional discussion of some of these points is required. Data were collected only for continental US airbases because pollutant data were available only for them. The algorithms could be used in abbreviated form with only weather and geographical data. In some cases this would lead to useful results. For example, Anderson AFB, Guam would receive A, (probably) B, and AA ratings for washing, repaint, and corrosion severity, respectively, based only on these parameters. Ratings for less unique environments, however, would be ambiguous, and we chose not to compute them.

Weather data reported by ETAC are variable-year averages of hourly measurements and were obtained by weather stations located at the specific airbase in question. These stations did not report solar radiation measurements, hence the source listed in item (3) was used. These latter data are mean values for wide geographical regions and were computed from US Weather Bureau measurements. Values for July are used because these are near the maximum for the northern hemisphere. July values would be inappropriate elsewhere. Mean annual RH and temperature were used to compute mean annual absolute humidity.

Sulfur dioxide and particulate concentrations were available in the cited EPA documents as mean annual values and thus are directly compared with WECS. In the case of the NO_2 and O_3, however, available data frequently provided only first and second hourly maxima, which cannot be compared with the WECS annual mean values. Accordingly, we have substituted for these pollutants a secondary WECS equal to the 50-th percentile of Graedel and Schwartz[29] plus 0.8 of the difference between their 99-th and 50-th percentiles. The modified algorithm compares this secondary WECS with the reported hourly maximum.

Unlike the ETAC data, EPA's pollutant data were not measured at the airbase in question. We have selected data from the nearest EPA monitoring station and upwind of the airbase wherever possible. In the data listings (Appendix 3), latitude and longitude of both the relevant monitoring station and the airbase are included, together with the wind direction from the airbase.

d. Comparison of Algorithm Results with Corrosion Maintenance Experience

In-service testing usually involves a single component or test coupon and is conducted to evaluate: (a) the corrodibility of candidate alloys, (b) environmental corrosiveness, or (c) the effectiveness of maintenance. It is possible to derive similar information from the operational corrosion experience of complete systems, provided sufficiently detailed records of corrosion maintenance and repair are collected. Over the years, the U.S. Air Force has developed an extensive Maintenance Data Collection System (MDCS)[58] which routinely documents virtually every facet of maintenance on its aerospace systems. The resultant data files are a rich source of information for failure analysis, particularly with respect to corrosion. The maintenance and operational histories of the USAF C-141A Force have been analyzed.[6,30] The major thrust was a determination of relative environmental corrosiveness.

As of January 1976, 271 of these aircraft in the Military Aircraft Command were stationed at Altus OK, Charleston, SC, McChord, WA, McGuire, NJ, Norton, CA, and Travis, CA. Formerly, some were stationed at Dover, DE and Robins, GA. Occasionally individual aircraft are transferred from one airbase to another, but frequent or large reassignments are rare. Within the time period of study, transfer of significant numbers of units occurred twice as a result of reorganizations. Individual unit transfers are effected in order to spread the wear and tear of training-base missions over the entire force. Despite these transfers, approximately 250 units were stationed at not more than two airbases, and more than 100 at a single airbase during the same time period under study. The number of aircraft at

any particular airbase ranges from fewer than twenty to as many as sixty.

With the exception of a training squadron, the bulk of the C-141A Force is oriented to airlift missions. Such missions account for about 80% of flying hours, while training and miscellaneous missions account for 9% and 11%, respectively. A comparison of cumulative flying hours with age shows that these aircraft spend at least 80% of their time on the ground, most of that at the home station airbase. Accordingly, environmental factors at the home station will dominate the corrosion experience of these aircraft.

(1) Environmental Factors at C-141A Airbases

Environmental factors for the six current C-141A airbases from Appendix 4 are compared with the WECS values in Table 9. From this comparison and the use of the Corrosion Damage Algorithm, the relative corrosion severity of these airbases would be ranked as:

Travis, Charleston > McChord > Norton, Altus > McGuire

where Travis is the most severe and McGuire is the mildest. Those separated by commas are relatively close in their ratings. A combined average severity, using the results from all three algorithms yields the rankings

Travis, Charleston, Norton > McChord > Altus > McGuire

The increased severity of Norton results from the Los Angeles based smog factors.

(2) The USAF Maintenance Data Collection System

Thoroughly detailed records are kept by the Air Force for a wide variety of maintenance actions. Generally, actions which correct failures or defects and those which modify aircraft are documented. Routine servicing, e. g., washing, cleaning, touchup painting, is not. The data used in this study were extracted from the permanent maintenance records maintained on magnetic tape by the AF Logistics Command. Procedures and rules for data collection are detailed in the relevant AF manuals.[58]

An aircraft maintenance action begins with a discrepancy

TABLE 9. ENVIRONMENTAL FACTORS FOR C-141A AIRBASES COMPARED WITH WORKING ENVIRONMENTAL CORROSION STANDARDS AND ENVIRONMENTAL RATINGS

	Environmental Factors[1]							Environmental Ratings[2]		
Airbase	D2C 4.5	TSP 61	SO_2 43[2]	PCOX 79	AH 7.1	RF 1250	h 600	wash	repaint	corrosion
Altus OK	>4.5	67	?	?	9.1	(610)	600	B	(C)	A
Charleston SC	4	53	5	?	12.3	1196	500	A	(C)	AA
McChord WA	10	69	17	59	7.9	1043	550	B	B	A(A)
McGuire NJ	>4.5	(<75)	?	(320)	7.7	1105	500	B	B	B
Norton CA	>4.5	113	23	588	16.1	293	650	B	A	A
Travis CA	4	(<75)	?	255	9.0	(410)	424	A	B	AA

[1]Environmental Factors D2C, TSP, SO_2, PCOX, AH, RF, and hv are distance to sea (km), total suspended particulates ($\mu g/m^3$, annual mean), sulfur dioxide ($\mu g/m^3$, annual mean), photochemical oxidants as ozone (second 1-hour maximum), absolute humidity (g/m^3), rainfall (mm, annual mean), and solar radiation (Langley's, mean July). WECS values are listed at the top of each column. Question marks indicate no data available. Values in parentheses are estimates from Reference 55 or 56.

[2]Environmental Ratings are based on the algorithms of Figures 3, 4, and 5.

report (or a modification technical order), the majority of which are generated at a regularly-scheduled inspection. These inspections occur at isochronal intervals varying from 15 days to 36 months. They also vary in the depth of inspection, the most thorough being the Programmed Depot Maintenance and the Mid-Interval inspection.

A discrepancy report and subsequent maintenance events are recorded on AFTO form 349 (Figures 6, 7). Periodically these are key-punched and entered into the airbase computer system. Portions of this data are forwarded to AFLC where they are analyzed and deposited into the permanent record files. Certain categories of maintenance data, essentially those which can be considered as "overhead" costs and not failure-related, are not entered into the permanent files. Information entered on the AFTO 349 form which reaches the permanent files and is relevant are discussed as follows:

(1) The Work Unit Code identifies the system, subsystem, and component on which maintenance is effected. Certain work unit codes identify tasks of a general "overhead" nature and are used to record labor costs only and have only base-level significance.

(2) Action Taken Code indicates the specific kind of maintenance action effected, e.g., removal and replacement.

(3) How-malfunctioned Code identifies the nature of the defect rather than the cause of the discrepancy. Thus maintenance personnel are required to perform a certain amount of diagnosis.

In general, these records provide the journalists' "what, where, when, why, and how" answers with respect to maintenance actions on aircraft. Of particular interest is the opportunity to perform cost-analyses based on the manhours expended for various tasks at a given airbase and to make comparisons from one airbase to another. These comparisons in turn can be coupled with the relevant environmental factors to determine the relative corrosivity of a given airbase.

1. JOB CONTROL NO.	2. WORK CENTER	3. I.D. NO./SERIAL NO.	4. MDS	5. W.O. NO. PREFIX	SUFFIX	6. TIME	7. PRI	8. SORTIE NO.	9. LOCATION

10. ENG. TIME	11. ENGINE I.D.	12. INST. ENG. TIME	13. INST. ENG. I.D.	14.	15.	16.	17. TIME SPEC REQ	18. JOB STD.

19. FSC	20. PART NUMBER	21. SER. NO./OPER. TIME	22. TAG NO.	23. INST. ITEM PART NO.	24. SERIAL NUMBER	25. OPER. TIME

	A CARD AND ITEM NO	B TYPE MAINT	C WORK UNIT CODE	D ACTION TAKEN	E WHEN DISC	F HOW MAL	G UNITS	H START DAY	H START HOUR	I STOP DAY	I STOP HOUR	J CREW SIZE	K MAN NUMBER
1			11CAA	Z		170	3					2	
2													
3													
4													
5													

26. DISCREPANCY

fasteners corroded

27. CORRECTIVE ACTION

replaced fasteners, treat corrosion

28 RECORDS ACTION

AFTO FORM JAN 68 349 MAINTENANCE DATA COLLECTION RECORD M & W INC. 4 68—160MM

Figure 6. USAF AFTO Form 349 Maintenance Data Collection Record.

29. PARTS REPLACED DURING REPAIR

LINE NUMBER	A FSC	B PART NUMBER	C WORK UNIT CODE	D REF. SYMBOL	E HOW MAL	F QTY.

30.
CONTINUATION FROM BLOCK ______

Figure 7. USAF AFTO Form 349 Maintenance Data Collection Record (reverse)

TABLE 10. DISTRIBUTION OF C-141A FORCE-WIDE CORROSION MAINTENANCE MANHOURS AMONG ACTION TAKEN CODES.[32]

Action Taken	4Q70-4Q74%	1Q75-4Q76%
Repairs and/or Replacement of minor parts, etc.	45.2	41.4
Corrosion (Repair)	11.0	14.3
Clean	8.9	12.8
Repair	8.5	3.8
Remove and Replace	17.7	18.1
Removed	5.7	5.4

TABLE 11. DISTRIBUTION OF C-141A FORCE-WIDE CORROSION MAINTENANCE MANHOURS AMONG HOW-MALFUNCTION CODES.[32]

How Malfunction	4Q70-4Q74%	1Q75-4Q76%
Corrosion*	37.4	42.2
Cracked	34.1	36.3
Coating, sealant failure	17.9	7.7
Other related codes	8.7	10.9

*Includes corroded, deteriorated, and delaminated.

Data base. The permanent maintenance records of C-141A aircraft were provided on magnetic tape and spanned two time periods: fourth calendar quarter 1970 through fourth quarter 1974; and first quarter 1975 through fourth quarter 1976. These records included both organizational (field) level and depot-level maintenance. The two data sets were analyzed separately using the second to check predictions made from the first.

Two smaller files of corrosion-related data were created from these data files by selecting records containing one of several corrosion how-malfunctioned codes or action-take codes. The resulting corrosion data base, in two-parts, consisted of

(a) 4Q70-4Q74, 234, 046 records, 890, 502 manhours, and

(b) 1Q75-4Q76, 90, 933 records, 273, 555 manhours

As discussed earlier, aircraft corrosion maintenance may be divided into three distinctly different categories: (a) washing and cleaning as preventive maintenance; (b) maintenance of protective coatings and repainting; (c) repair of corrosion damage. The permanent files of the USAF MDCS should not contain any records relating to the first two categories because corrosion prevention, in effect, is not documented. The distribution of the data base among major corrosion how-malfunction codes is shown in Table 10, and among action taken codes in Table 11.

In addition to the maintenance data files, operational histories of each aircraft were provided. These histories detailed chronologically airbase assignments and flight information over the same time periods.

(3) Results

One would expect the maintenance manhours to be distributed among the several airbases more or less in proportion to the number of aircraft assigned to each base. Airbase assignments for each aircraft, which were included in the operational histories, were available on a calendar quarter basis. Reassignments did not occur exactly at the end of any given quarter, of course, but the calendar quarter possessions for each airbase were used for comparative purposes. Thus the percent of aircraft possession quarters for a given airbase represents that

airbase's share of maintenance responsibility for the C-141A force, all other factors being equal. If its actual share of the maintenance effort is larger or smaller than its responsibility, then one would look for other factors, e.g., environmental, which would cause the discrepancy.

Possession quarters and corrosion manhours are listed in Table 12 as percents of the totals for the two time periods considered. In three cases, e.g., Altus, McGuire and McChord, the actual figures are quite close to the responsibility values. In the other three, Travis, Charleston, and Norton, there are considerable differences. Thus there is clear indication of base-to-base variations in the amount of corrosion maintenance effort expended per aircraft. Airbase comparisons using the data format of Table 10 are not useful, however, because of distortions intorduced when one or two airbases contribute an abnormally high or low input to the data files. This occurred in the second time period where large amounts of data turned out to be missing for Norton AFB. The result is to inflate the apparent share of the data base for every other airbase.

The rate of field corrosion maintenance, i.e., the slope of manhours vs. time Figure 8, was found to be essentially linear. Moreover, the rate was constant for all aircraft assigend to a given airbase, but varied from one airbase to another. Average repair rates for all aircraft assigned to a given airbase were computed and are shown in Table 13 where the data are listed as manhours per aircraft per calendar quarter. Repair rates and their trends of slight change were used to compute predicted repair rates for the second time period. These predicted values are also listed in Table 1[illegible]. Actual Values and predicted values are in quite good agreement, with the exception of Norton AFB, for which, as has been noted, large gaps were found in the data files.

A statistical comparison was made of maintenance efforts on those individual aircraft which were stationed continuously at a given airbase, the results of which are shown in Figures 9 and 10. These figures show corrosion manhours per quarter

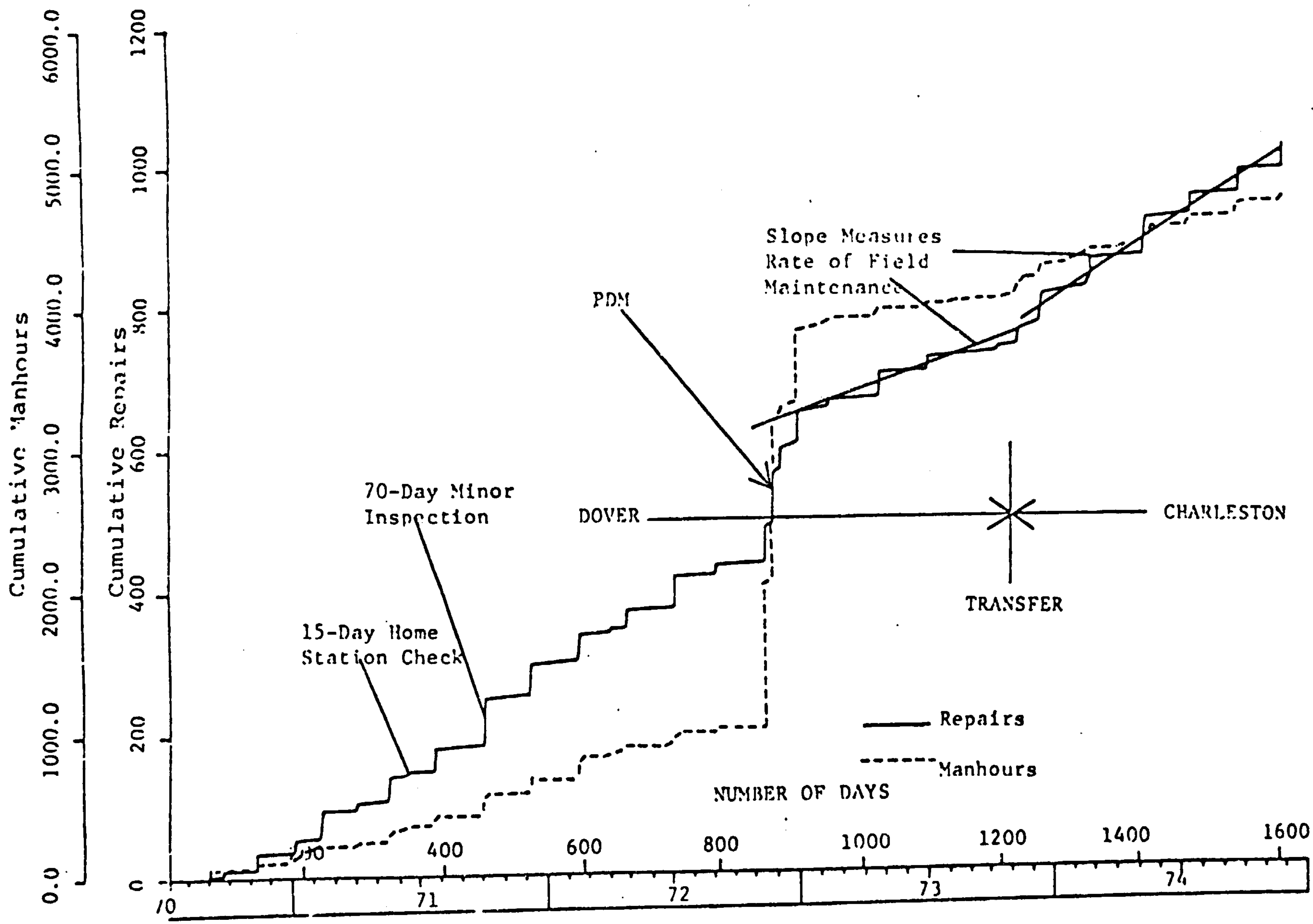


Figure 8. Cumulative Corrosion Maintenance History of C-141A Serial Number 650266

TABLE 12. C-141A AIRBASE POSSESSION QUARTERS COMPARED WITH FIELD LEVEL CORROSION MAINTENANCE MANHOURS.[32]

		4Q70-4Q74*		1Q75-4Q76	
	Airbase	Possession Quarters, %	Corrosion Manhours, %	Possession Quarters, %	Corrosion Manhours, %
1.	Altus	6.7	6.5	6.4	5.2
2.	Charleston	16.9	18.5	21.8	30.4
3.	McChord	14.6	14.4	13.9	12.5
4.	McGuire	21.2	18.1	20.7	20.0
5.	Norton	19.1	15.5	22.2	8.4
6.	Travis	16.4	21.8	15.0	23.6

*Total is less than 100% because Dover AFB data is not listed.

TABLE 13. C-141A CORROSION MAINTENANCE EFFORT BY AIRBASE.[32]

		Manhours per Aircraft per Quarter	
		4Q1970-4Q1974	1Q1975-4Q1976*
1.	Altus, OK	98.8	63.7 (84.3)
2.	Charleston, SC	113.2	110.0 (105.6)
3.	McChord, WA	101.2	70.8 (52.8)
4.	McGuire, NJ	87.7	76.1 (79.5)
5.	Norton, CA	84.4	29.7** (58.8)
6.	Travis, CA	133.0	124.0 (101.4)

*Values in parentheses were projected from those of first time period.

**Data files were incomplete.

for individual aircraft vs. the percent of total population. Variations from one airbase to another are clearly apparent, with Travis aircraft showing the highest and Norton the lowest maintenance efforts. (Altus AFB is not included because only one aircraft was stationed there continuously during either time period.) Indeed, the one aircraft at Travis which received the fewest maintenance manhours, received more than that at Norton receiving the largest in the first time period (for which Norton data were complete). In other words, the most poorly-maintained Travis airplane received more corrosion repair maintenance than the best-maintained Norton unit. Moreover, the average Travis aircraft received, in 1970-74, approximately 150 manhours per quarter--more than any airplane received at McGuire, McChord, and Norton, and more than 90% of the airplanes at Charleston! The results for 1975-76 are essentially the same.*

Field maintenance effort also was compared for selected areas of the aircraft (according to work unit codes). Shown in Table 14 are the average corrosion manhours per aircraft per quarter spent on forward and center fuselage, center wing-box beam, and wings. These regions were selected for illustration here so that mission-related damage is separated. For example. training-oriented missions at Altus AFB are especially severe on components related to take off and landing such as landing gear and wing flaps. The same general patterns of maintenance effort are observed.

In summary, field maintenance data consistently rank these six airbases as

Travis, Charleston > McChord, McGuire > Altus > Norton,

from highest to lowest. Some minor shuffling is observed between McGuire and McChord, and Norton, Altus, and McGuire is rated

*The value of Figures 9 and 10 differ slightly from those of Table 13 because the latter includes all aircraft stationed at a given airbase, whereas the figures include only those continuously stationed (i.e., not transferred) during the respective time periods. Maintenance rates are distorted slightly at transfer.

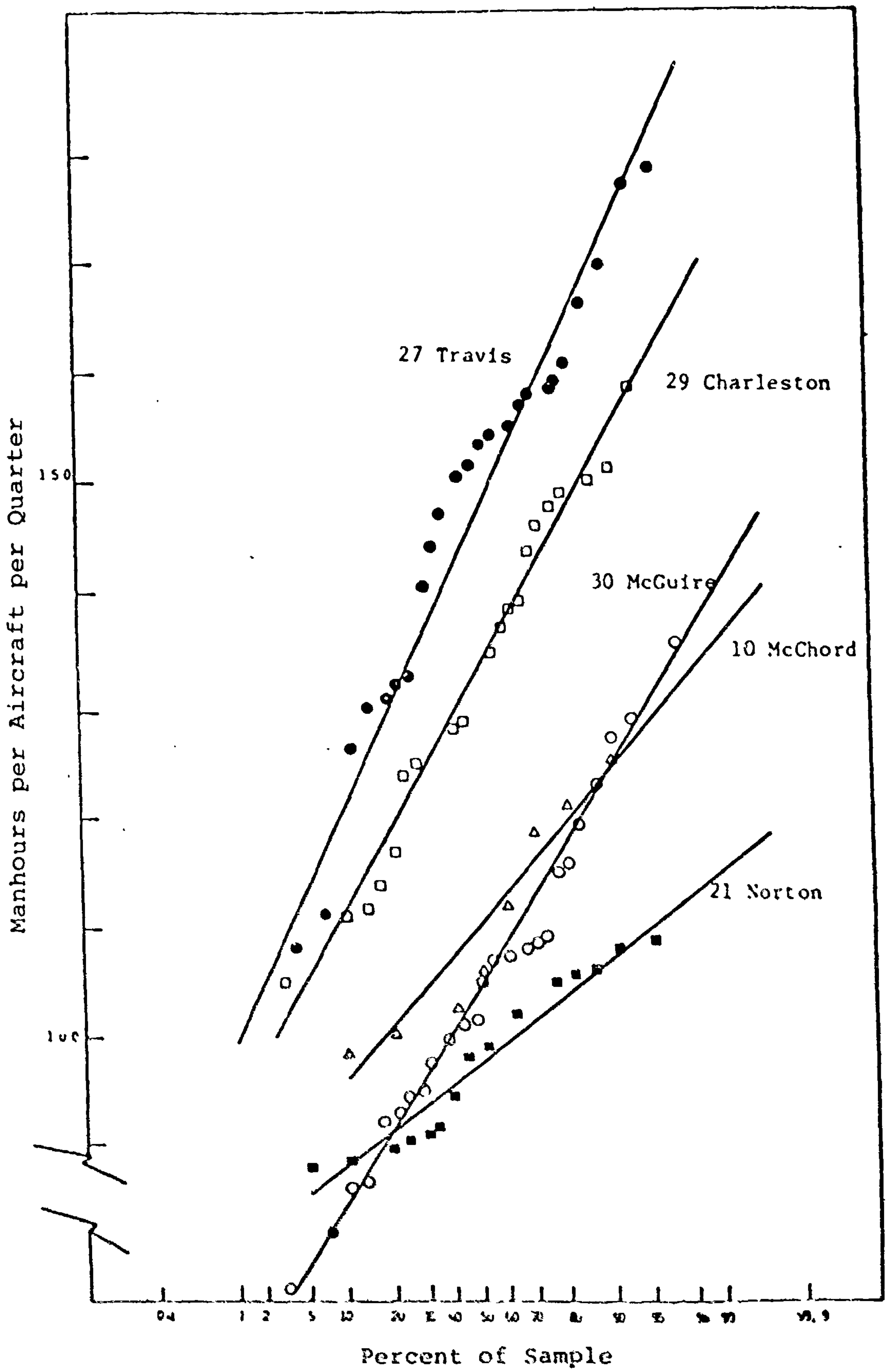


Figure 9. Distribution of Field-level Corrosion Maintenance Among Aircraft Continuously Assigned to an Airbase 4Q70-4Q74. Numbers Indicate Size of Sample.[32]

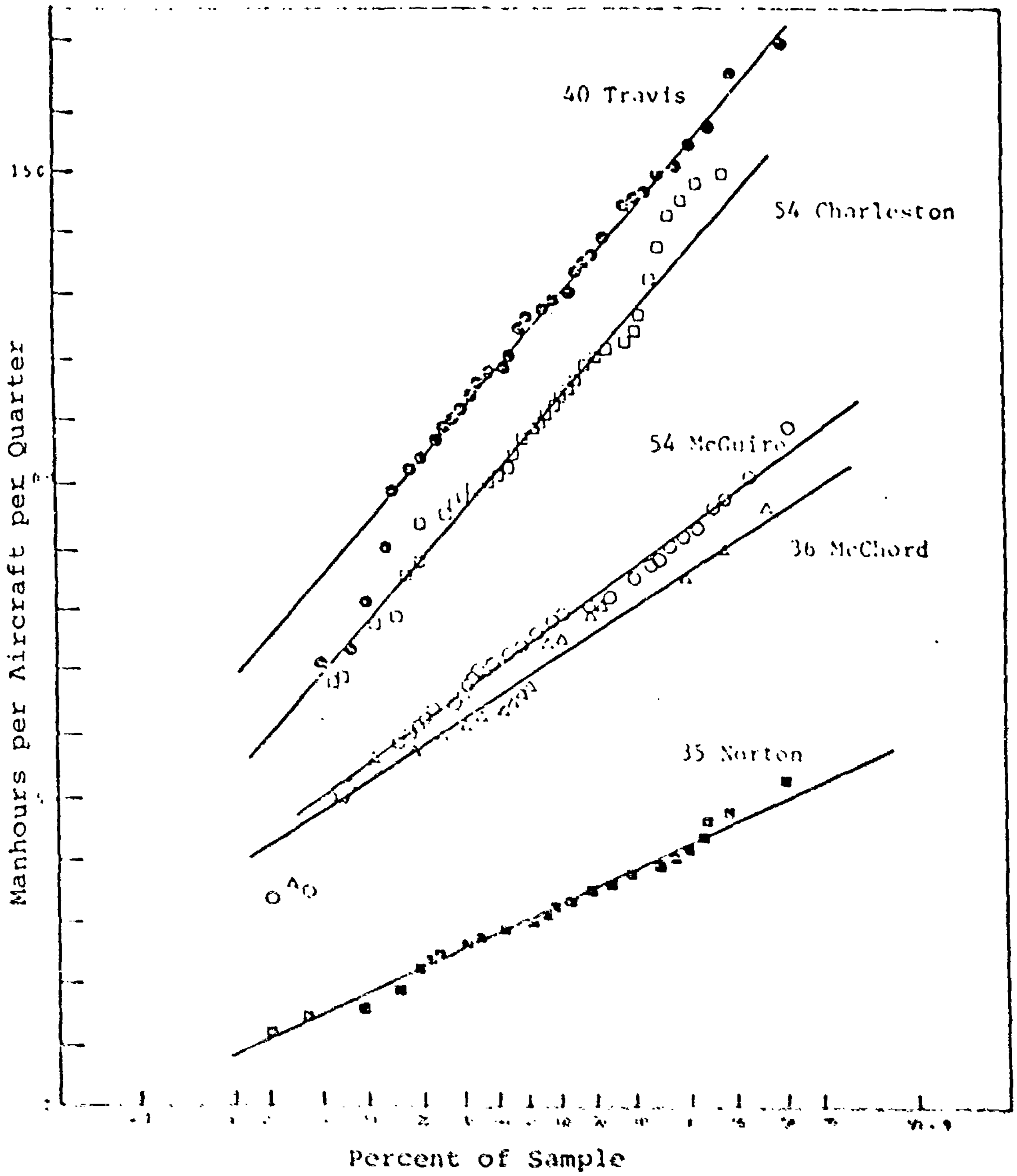


Figure 10. Distribution of Field-level Corrosion Maintenance Among Aircraft Continuously Assigned to an Airbase 1Q75-4Q76. Numbers Indicate Size of Sample[32]

TABLE 14. C-141A CORROSION MAINTENANCE EFFORT* ON SELECTED AIRCRAFT SECTIONS BY AIRBASE.[32]

		Forward and Center Fuselage		Wing and Wing Box Beam		Totals	
		4Q70-4Q74	1Q75-4Q76	4Q70-4Q74	4Q74-4Q76	4Q70-4Q74	4Q75-4Q76
1.	Altus, OK	7.6	5.0	6.7	10.6	14.3	15.6
2.	Charleston, SC	20.1	23.5	14.0	19.6	34.1	43.1
3.	McChord, WA	17.3	7.3	11.1	19.2	28.4	26.5
4.	McGuire, NJ	13.0	7.1	7.5	10.4	20.5	17.5
5.	Norton, CA	12.9	**	6.4	**	19.3	**
6.	Travis, CA	19.8	17.6	15.0	22.1	34.8	39.7

*Manhours per aircraft per quarter.

**Datafiles incomplete.

lower by the algorithms than by maintenance. The listing based on environmental parameters as discussed earlier. The maintenance data could be used in a quantitative comparison, but the environmental ratings are not directly suitable for such treatment.

(4) Conclusions

The results show clearly that detailed corrosion maintenance records of complex systems correlated well with environmental severity indexes derived from the CSI Algorithm based on the known corrosive factors. Indeed it appears that a numerical corrosion severity index can be formulated from such data. Such an index would be at least as precise as any developed from atmospheric testing of alloys. Moreover, it should be possible to focus attention on specific alloys in the system rather than applying to a variety of alloys as we have done so far.

There are a few problems relating to the USAF Maintenance Data Collection System, however, which make further progress difficult at this time. These problems mainly are the loss of certain kinds of data which, in most cases, is inherent to the system itself. Another problem is the variability of data reporting practices from one repair facility to another. These problems are the subject of continuing study at Michigan State University.

e. Comparison With PACER LIME Experimental Results

The experimental phase of PACER LIME was expected to provide test data for "calibrating" the Corrosion Factor equation. Alloys representative of airframe construction were fastened to outdoor test racks at several airbases spanning the range of mildest to most severe environments. These alloy panels were removed and weighed at six month intervals. The data from these tests have been analyzed and the results are reported in Part II of this report.

The experimental results are not as useful as one might have hoped..

(1) Some of the alloys tested were not suitable for the program. Specifically, the aluminum alloys (2024-T3 alclad,

7075-T6, and 7079-T6 alclad) are relatively resistant to general corrosion and weight losses over the time period tested were quite small, thus subject to large experimental error. The titanium alloy (Ti-6Al-4V) was essentially corrosion resistant and thus provided no useful data.

(2) The environments for which data were available are fairly comparable; no data were obtained from the most severe environments.

(3) Methods for cleaning panels prior to weighing (mechanical scrubbing) are not reproducibly effective in removing corrosion products, thus results are widely variable from one technician to another.

(4) Although this was a large and complex program, a disproportionate share of misfortune plagued it.

When all these factors are considered, it is difficult to give serious weight to the apparent relative corrosivity of each testing site as reflected in these test data. Nevertheless, these results show the sites tested to be ranked as

Andrews, Wright-Patterson, Barksdale > Robins > F.E. Warren,

from worst to mildest, for those sites which yielded any data.

These experimental corrosion severity rankings should be most comparable with the rankings obtained from the Corrosion Damage Algorithm. Using that algorithm, the same airbases are ranked as

Andrews, Wright-Patterson, Robins, > Barksdale > F.E. Warren

The rankings based on the experimental test program and those based on the Corrosion Damage Algorithm are seen to be in excellent agreement, except for the reversal of Barksdale and Robins. While we find this agreement comforting, at the same time we are aware of the severe confidence limitations that must be placed on the experimental results. It is our view that the experimental test results should not be interpreted as strongly supportive of the algorithm rankings, but, nevertheless, do not present contradictory evidence which must be "explained away." Therefore, the experimental and algorithm are considered to be in good agreement.

6. Conclusion

The concept of an Environmental Corrosion Severity Classification was proposed by USAF AFLC personnel at Warner-Robins AMA in 1971. This classification was to be used for anticipating corrosion damage to aircraft and scheduling appropriate repairs. The USAF Interim classification method has been extended to the algorithm format described in this report. Using these algorithms, airbase classifications have been obtained which are in excellent agreement with USAF maintenance experience, as contained within the AFM 66-1 maintenance records, and in good agreement with an experimental testing program conducted by USAF. As research on aircraft corrosion problems continues, modifications to these algorithms can be expected. At this time, they are considered to be the best tools available for relating environmental risk to aircraft maintenance, and, accordingly are recommended to USAF as working tools for corrosion management.

REFERENCES

1. Bennett, L. H., Kurger, J., Parker, R. L., Passaglia, E., Reimann, C., Ruff, A. W., and Yakowitz, H., "Economic effects of metallic corrosion in the United States," U.S. Department of Commerce, National Bureau of Standards, March 1970.

2. Hahin, C., "Corrosion costs of Air Force and Army facilities and construction of a cost prediction model," U.S. Army Construction Engineering Research Laboratory, Technical Report M-224, July 1977.

3. Hahin, C., "Predicting the metallic corrosion costs of operating and maintaining buildings and utilities systems," Materials Performance 17, 31-34 (1978).

4. Setter, L. C., "AFLC's corrosion and maintenance problems," Proceedings of AFOSR/AFML Corrosion Workshop, October 1977, AFML-TR-77-175.

5. Upp, J. R., "The Air Force corrosion program," "Proceedings of the 1976 Tri-Service Conference on Corrosion," Ketchem, S. J., Ed., 26-28 October, 1976, Metals and Ceramics Information Center, Battelle, Columbus, Ohio, MCIC Report 77-33.

6. Summitt, R., "Corrosion tracking and prediction for C-141A aircraft maintenance scheduling," AFML-TR-78-29, Air Force Materials Laboratory, Wright-Patterson AFB, OH, 1978.

7. Tomashov, N. D., "Theory of corrosion and protection of metals," Translated and edited by Tytell, E. H., Geld, I., and Preiser, H. S., McMillan, New York, 1966.

8. Ailor, W. H., "ASTM atmospheric corrosion testing: 1906 to 1976," "Atmospheric Factors Affecting the Corrosion of Engineering Metals, ASTM STP 646," S. K. Coburn, Ed., American Society for Testing and Materials, 129-151, 1978.

9. Rozenfeld, I. L., "Atmospheric corrosion of metals," B. H. Tytell, transl., National Association for Corrosion Engineers, Houston, TX, 1972.

10. Sereda, P. J., "Weather factors affecting corrosion of metals," "Corrosion in Natural Environments, ASTM STP 558," American Society for Testing and Materials, 7-22, 1974.

11. ASTM, "Corrosiveness of various atmospheric test sites as measured by specimens of steel and zinc," "Metal Corrosion in the Atmosphere, ASTM STP 435," American Society for Testing and Materials, 360-391, 1968.

12. Ailor, W. H., Jr., "Performance of aluminum alloys at other test sites," "Metal Corrosion in the Atmosphere, ASTM STP 435," American Society for Testing and Materials, 285-307, 1968.

13. Ailor, W. H., "Seven-year exposure at Point Reyes, California," "Corrosion in Natural Environments, ASTM STP 558," American Society for Testing and Materials, 75-81, 1974.

14. Baboian, R., "Final report on the ASTM study: Atmospheric galvanic corrosion of magnesium coupled to other metals," "Atmospheric Factors Affecting the Corrosion of Engineering Metals, ASTM STP 646, S. K. Coburn, Ed., American Society for Testing and Materials, 17-29, 1978.

15. Scheffer, T. C., "A climate index for estimating potential for decay in wood structures above ground," Forest Products J. 21, 25-31 (1971).

16. Moore, T. K., "Environmental effects on maintenance costs for aircraft equipment," AFML TR-76-31, AF Wright Aeronautical Laboratories, Wright-Patterson AFB, OH, 1976.

17. Vernon, W. H. J., Trans. Faraday Soc. 27, 265-277, (1931).

18. Vernon, W. H. J., Trans. Faraday Soc. 31, 1668-1700, (1935).

19. Grossman, P. R., "Investigation of atmospheric exposure factor that determine time-of-wetness of outdoor structures," "Atmospheric Factors Affecting the Corrosion of Engineering Metals, ASTM STP 646," S. K. Coburn, Ed., American Society for Testing and Materials, 1978.

20. Oke, T. R., "Boundary layer climates," Methuen, London, 1978.

21. Guttman, H., and Sereda, P. J., "Measurement of atmospheric factors affecting the corrosion of metals," "Metal Corrosion in the Atmosphere, ASTM STP 435," American Society for Testing and Materials, 326-359, 1968.

22. U.S. Department of Health, Education and Welfare, "Air quality criteria for particulate matter," January 1969, National Air Pollution Control Administration Publication AP-49.

23. U.S. Department of Health, Education and Welfare, "Air quality criteria for sulfur oxides," January 1969, National Air Pollution Control Administration Publication AP-50.

24. Likens, G. E., "Acid precipitation," Chemical and Engineering News, Nov. 22, 1976, 29-44.

25. Gillette, D. G., 1975, "Sulfur dioxide and material damage," J. Air Pollution Control Assoc. 25, 1238-1243 (1975).

26. U.S. Department of Health, Education and Welfare, "Air quality criteria for hydrocarbons," March 1970, National Air Pollution Control Administration Publication AP-64.

27. U.S. Department of Health, Education and Welfare, "Air quality criteria for photochemical oxidents," March 1970, National Air Pollution Control Administration Publication AP-63.

28. U.S. Environmental Protection Agency, "Air quality criteria for nitrogen oxides," January 1971, National Air Pollution Control Administration Publication AP-84.

29. U.S. Environmental Protection Agency, "National air quality and emissions trend report, 1976," EPA-450/1-77-002.

30. Stoker, H. S., and Seager, S. L., "Environmental chemistry: air and water pollution," 2nd edn., Scott, Foresman and Co., Glenview, IL, 1976.

31. Graedel, T. E., and Schwartz, N., "Air quality reference data for corrosion assessment," Materials Performance 16, 17-25, August, 1977.

32. Summitt, R., "Forecasting corrosion damage and maintenance costs for systems of large aircraft: Environmental corrosiveness," CORROSION/80, Chicago, March 6-10, 1980.

33. Shaw, T. R., "Corrosion maps of the British Isles," "Atmospheric Factors Affecting the Corrosion of Engineering Metals, ASTM STP 646," S. K. Coburn, Ed., American Society for Testing and Materials, 204-215, 1978.

34. Hudson, J. C., and Stanner, J. F., J. Iron and Steel Inst. 180, 271 (1955).

35. Junge, C. E., and Gustafson, "On the distribution of sea salt over the United States and removal by precipitation," Tellus 9, 164 (1957).

36. Junge, C. E., "Air chemistry and radioactivity," Academic Press, New York, 1963.

37. Duce, R. A., Winchester, J. W., and Van Nahl, T. W., "Iodine, bromine, and chlorine in the Hawaiian marine atmosphere," J. Geophysical Res. 70, 1775 (1965).

38. Pueschel, R. S., Charlson, R. J., and Ahlquist, N. C., 1969, "On the anomalous deliquescence of sea-spray aerosols," J. Appl. Meteorol. 8, 995-998 (1969).

39. Junge, C. E., "The chemical composition of atmospheric aerosols I: Measurements at Round Hill Field Station, June-July 1953," J. Meteorol. 11, 323-333 (1954).

40. Federal Register 36, 1502 (1971).

41. Federal Register 36, 8186 (1971).

42. Upham, J. B., 1967, "Atmospheric corrosion studies in two metropolitan areas," J. Air Pollution Control Assoc. 17, 398-403 (1967).

43. Mansfield, F., "Results of thirty-six months exposure study in St. Louis, MO," CORROSION/78, Houston, TX, 1978.

44. Mansfield, F., "Regional air pollution study effects of airborne sulfur pollutants on materials," EPA-600/4-80-007, January 1980.

45. Haynie, F. H., and Upham, J. B., "Effects of atmospheric sulfur dioxide on the corrosion of zinc," Materials Performance 9, 35-40 (1970).

46. Haynie, F. H., and Upham, J. B., "Correlation between corrosion behavior of steel and atmospheric data," "Corrosion in Natural Environments, ASTM STP 558, American Society for Testing and Materials, 33-51, 1974.

47. Haynie, F. H., Spence, J. W., and Upham, J. B., "Effects of air pollutants on weathering steel and galvanized steel: a chamber study," "Atmospheric Factors Affecting the Corrosion of Engineering Materials, ASTM STP 646," S. K. Coburn, Ed., American Society for Testing and Materials, 30-47, 1978.

48. Weast, R. C., ed., "Handbook of chemistry and physics," 51st edn., CRC Press, W. Palm Beach, FL, E-5, 1971.

49. Hairston, F. H., "Assignment of environmental areas for SAC KC-135/B-52 bases," unpublished, 1956.

50. Richard, O. E., and Snelling, H. J., "Weather data and its use in corrosion studies," "Proceedings of the 1974 Triservice Corrosion of Military Equipment Conference, 29-31 October 1974," Volume II, 325-327, 1975.

51. Jellinek, H. H. G., 1979, J. Air Pollution Control Assoc. 29, 672 (1979).

52. United States Air Force, "Exterior finishes, insignia, and markings applicable to USAF aircraft," T. O. 1-1-4, 1973.

53. Cohen, B., private communication, 1976.

54. United States Air Force Environmental Technical Applications Center, "Worldwide airfield climatic data," Vols. I-VIII, Washington, D.C., 1970.

55. Baldwin, J. L., "Climates of the United States," U.S. Department of Commerce, Washington, D.C., 1973.

56. U. S. Environmental Protection Agency, "Air quality data - 1976 annual statistics," March 1978, EPA-450/2-78-009.

57. U. S. Department of Commerce, "Sectional aeronautical charts," Washington, D.C., 1979.

58. "The maintenance data collection system," USAF TO 00-20-2, Secretary of the Air Force, Washington, 1975.

59. National Climatic Center, Asheville, NC, "WBAN station numbers master list," August 1978.

60. United States Air Force AFM 300-4 Volume XV, 15 April 1975.

61. U. S. Environmental Protection Agency, "Directory of air quality monitoring sites active in 1976," EPA-450/2-78-002, February 1978.

APPENDIX A

PACER LIME Interim
Corrosion Severity Classification

PACER LIME INTERIM CORROSION SEVERITY CLASSIFICATION

1=	AL ANG BIRMINGHAM MUNI APRT AL	2.50 MOD
2=	ALBROOK AFB BALBOA CANAL ZONE	1.67 SEV
3=	ALTUS AFB OK	2.83 MOD
4=	ANDERSEN AFB GUAM	2.17 MOD
5=	ANDREWS AFB WASHINGTON DC	2.50 MOD
6=	AR ANG FORT SMITH MUNI APRT AR	2.33 MOD
7=	BARKSDALE AFB LA	2.83 MOD
8=	BEALE AFB CA	2.83 MOD
9=	BERGSTROM AFB AUSTIN TX	2.50 MOD
10=	BLYTHEVILLE AFB AR	2.50 MOD
11=	BUCKLEY ANGB DENVER CO	3.00 MIL
12=	CA ANG FRESNO CA	2.67 MIL
13=	CA ANG OAKLAND CA	1.67 SEV
14=	CA ANG VAN NUYS CA	2.33 MOD
15=	CANNON AFB CLOVIS NM	3.17 MIL
16=	CARSWELL AFB TX	3.00 MIL
17=	CASTLE AFB CA	2.83 MOD
18=	CHARLESTON AFB SC	2.50 MOD
19=	COLUMBUS AFB MS	2.50 MOD
20=	CRAIG AFB SELMA AL	2.67 MOD
21=	CT ANG BRADLEY FLD WINSOR LOCKS CT	2.50 MOD
22=	DAVIS MONTHAN AFB AZ	3.33 MIL
23=	DE ANG GREATER WILMINGTON APRT NEW CASTLE DE	2.17 MOD
24=	DOBBINS AFB GA	2.50 MOD
25=	DOVER AFB DE	1.83 SEV
26=	DULUTH INTL APRT MN	2.67 MOD
27=	DYESS AFB TX	3.17 MIL
28=	EDWARDS AFB CA	3.33 MIL
29=	EGLIN AFB VALPARAISO FL	1.83 SEV
30=	EIELSON AFB AK	2.67 MOD
31=	ELLSWORTH AFB SD	2.67 MOD
32=	ELMENDORF AFB ANCHORAGE AK	1.83 SEV

33=	ENGLAND AFB ALEXANDRIA LA	2.50 MOD
34=	FAIRCHILD AFB WA	2.67 MOD
35=	FL ANG JACKSONVILLE FL	2.17 MOD
36=	FORBES AFB TOPEKA KS	2.67 MOD
37=	FRANCIS E WARREN AFB WY	3.00 MIL
38=	GA ANG TRAVIS FLD SAVANNAH GA	2.17 SEV*
39=	GEORGE AFB VICTORVILLE CA	3.33 MIL
40=	GOODFELLOW AFB SAN ANGELO TX	2.83 MOD
41=	GRAND FORKS AFB ND	2.50 MOD
42=	GRIFFISS AFB NY	2.50 MOD
43=	GRISSOM AFB IN	2.33 MOD
44=	HAMILTON AFB SAN RAFAEL CA	1.67 SEV
45=	HANSCOM AFB BEDFORD MA	2.00 SEV
46=	HICKAM AFB HI	2.50 MOD
47=	HILL AFB OGDEN UT	3.33 MIL
48=	HOLLOMAN AFB ALAMOGORDA NM	3.33 MIL
49=	HOMESTEAD AFB FLA	2.00 SEV
50=	HOWARD AFB CANAL ZONE	1.83 SEV
51=	IA ANG DES MOINES IA	2.33 MOD
52=	IA ANG SIOUX CITY MUNI APRT SERGEANTS BLUFF IA	2.33 MOD
53=	ID ANG BOISE ID	2.83 MOD
54=	IL ANG CAPITAL MUNI APRT SPRINGFIELD IL	2.50 MOD
55=	IL ANG GREATER PEORIA APRT IL	2.50 MOD
56=	IL ANG OHARE INTL APRT CHICAGO IL	2.33 MOD
57=	IN ANG BAER FLD FT WAYNE IN	2.17 MOD
58=	IN ANG HULMAN FLD TERRE HAUTE IN	2.50 MOD
59=	K I SAWYER AFB MI	2.33 MOD
60=	KEESLER AFB BILOXI MS	1.83 SEV
61=	KELL FLD WICHITA FALLS TX	3.00 MIL
62=	KELLY AFB SAN ANTONIO TX	2.83 MOD
63=	KINCHELOE AFB MI	2.17 MOD
64=	KINGSLEY FLD KLAMATH FALLS OR	2.83 MOD
65=	KIRTLAND AFB ALBUQUERQUE NM	3.33 MIL
66=	KY ANG LOUISVILLE KY	2.33 MOD
67=	LA ANG NEW ORLEANS NAS LA	1.83 MOD
68=	LANGLEY AFB HAMPTON VA	1.83 SEV

69=	LAREDO AFB TX	2.67 MOD
70=	LAUGHLIN AFB DEL RIO TX	3.00 MIL
71=	LITTLE ROCK AFB JACKSONVILLE AR	2.83 MOD
72=	LOCKBOURNE AFB OH	2.67 MOD
73=	LORING AFB ME	2.50 MOD
74=	LOS ANGELES INTL APRT CA	2.00 SEV
75=	LUKE AFB PHOENIX AZ	3.33 MIL
76=	MA ANG BARNES MUNI APRT WESTFIELD MA	2.50 MOD
77=	MACDILL AFB TAMPA FL	1.83 SEV
78=	MARCH AFB CA	2.50 MOD
79=	MATHER AFB CA	2.83 MOD
80=	MAXWELL AFB MONTGOMERY AL	2.50 MOD
81=	MCCHORD AFB TACOMA WA	2.00 SEV
82=	MCCLELLAN AFB SACRAMENTO CA	2.50 MOD
83=	MCCONNELL AFB KS	3.00 MIL
84=	MCCOY AFB FL	2.17 MOD
85=	MCGUIRE AFB WRIGHTSTOWN NJ	2.33 MOD
86=	MD ANG BALTIMORE MD	2.17 MOD
87=	ME ANG BANGOR INTL APRT ME	1.83 SEV
88=	MI ANG BATTLE CREEK MI	2.17 MOD
89=	MI ANG SELFRIDGE ANG BASE MI	2.17 MOD
90=	MINOT AFB ND	3.17 MIL
91=	MN ANG MINN-ST PAUL INTL APRT MN	2.67 MOD
92=	MO ANG ROSECRANS MEMORIAL APRT MO	2.67 MOD
93=	MOODY AFB VALDOSTA GA	2.50 MOD
94=	MOUNTAIN HOME AFB ID	2.83 MOD
95=	MS ANG JACKSON MUNI APRT MS	2.33 MOD
96=	MS ANG KEY FLD MERIDIAN MS	2.50 MOD
97=	MT ANG GREAT FALLS INTL APRT MT	3.17 MIL
98=	MYRTLE BEACH AFB SC	1.83 SEV
99=	NC ANG DOUGLAS MUNI APRT CHARLOTTE NC	2.83 MOD
100=	ND ANG STATE UNIVERSITY STN FARGO ND	2.67 MOD
101=	NE ANG BASE LINCOLN NE	2.33 MOD
102=	NELLIS AFB LAS VEGAS NV	3.33 MIL
103=	NJ ANG ATLANTIC CITY NJ	1.83 SEV
104=	NORTON SAN BERNADINO CA	2.50 MOD

105=	NV ANG RENO MUNI APRT NV	2.17 MOD
106=	NY ANG HANCOCK FLD SYRACUSE NY	2.33 MOD
107=	NY ANG NIAGARA FALLS INTL APRT NY	2.17 MOD
108=	NY ANG SCHENECTADY CO APRT NY	2.33 MOD
109=	NY ANG SUFFOLK CO ANG BASE NY	2.17 MOD
110=	NY ANG WESTCHESTER CO APRT NY	2.00 SEV
111=	OFFUTT AFB NE	3.00 MIL
112=	OH ANG MANSFIELD LAHM APRT OH	2.17 MOD
113=	OH ANG TOLEDO EXPRESS APRT SWANTON OH	2.33 MOD
114=	OK ANG TULSA OK	2.83 MOD
115=	OR ANG PORTLAND INTL APRT OR	2.00 SEV
116=	OTIS AFB FALMOUTH MA	1.83 SEV
117=	PA ANG GREATER PITTSBURGH APRT PA	2.17 MOD
118=	PA ANG MIDDLETOWN PA	2.83 MOD
119=	PA ANG WILLOW GROVE NAS PA	2.50 MOD
120=	PATRICK AFB COCOA BEACH FL	2.00 SEV
121=	PEASE AFB NH	2.00 SEV
122=	PETERSON FLD COLORADO SPRINGS CO	3.17 MIL
123=	PLATTSBURGH AFB NY	2.67 MOD
124=	POPE AFB FAYETTEVILLE NC	2.83 MOD
125=	RANDOLPH AFB SAN ANTONIO TX	2.83 MOD
126=	REESE AFB LUBBOCK TX	3.33 MIL
127=	RI ANG THEODORE GREEN APRT WARWICK RI	1.83 SEV
128=	RICHARDS GEBAUR AFB GRANDVIEW MO	2.83 MOD
129=	ROBINS AFB GA	2.83 MOD
130=	SC ANG MCENTIRE ANG BASE EASTOVER SC	2.50 MOD
131=	SCOTT AFB BELLEVILLE IL	2.50 MOD
132=	SD ANG JOE FOSS FLD SIOUX FALLS SD	2.67 MOD
133=	SEYMOUR JOHNSON AFB NC	2.33 MOD
134=	SHAW AFB SUMTER SC	2.83 MOD
135=	SHEMYA AFB AK	1.67 SEV
136=	TINKER AFB OKLAHOMA CITY OK	2.83 MOD
137=	TN ANG MCGHEE TYSON APRT KNOXVILLE TN	2.50 MOD
138=	TN ANG MEMPHIS MUNI APRT TN	2.83 MOD
139=	TN ANG NASHVILLE APRT STN TN	2.50 MOD
140=	TRAVIS AFB CA	2.50 MOD

141=	TX ANG HOUSTON TX	2.17 MOD
142=	TYNDALL AFB PANAMA CITY FL	1.83 SEV
143=	VA ANG BYRD FLD SANDSTON VA	2.17 MOD
144=	VANCE AFB ENID OK	2.83 MOD
145=	VANDENBERG AFB CA	1.67 SEV
146=	VT ANG BURLINGTON INTL APRT VT	2.33 MOD
147=	WA ANG SPOKANE INTL APRT WA	2.67 MOD
148=	WEBB AFB BIG SPRING TX	3.00 MIL
149=	WESTOVER AFB MA	2.50 MOD
150=	WHITEMAN AFB MO	2.83 MOD
151=	WI ANG GEN MITCHELL ANG BASE MILWAUKEE WI	2.33 MOD
152=	WI ANG MADISON WI	2.33 MOD
153=	WI ANG VOLK FLD ANG BASE CAMP DOUGLAS WI	2.33 MOD
154=	WILLIAMS AFB CHANDLER AZ	3.33 MIL
155=	WRIGHT PATTERSON AFB OH	2.67 MOD
156=	WURTSMITH AFB MI	2.17 MOD
157=	WV ANG KANAWHA CO APRT CHARLESTON WV	2.17 MOD
158=	WV ANG MARTINSBURG MUNI APRT WV	2.17 MOD

APPENDIX B

Programs developed to calculate
Washing and Repaint intervals
and Expected Corrosion Damage
severity using the Working
Environmental Corrosion Standards

```
      PROGRAM WASHER(INPUT,OUTPUT,PARAMS,
     +TAPE1=INPUT,TAPE2=OUTPUT,TAPE3=PARAMS)

C-----------------------------------------------------------------------C
C
C     WASHER - PROGRAM TO DETERMINE AIRCRAFT WASHING INTERVAL
C       BASED ON ENVIRONMENTAL DATA.
C
C     WRITTEN BY MATT RIZAI AND DAVID J. BURSIK
C       MICHIGAN STATE UNIVERSITY
C         04-FEB-80
C
C     THIS PROGRAM USES THRESHOLDS READ FROM A PARAMETER FILE
C     TO TRAVERSE A DECISION TREE FOR EACH BASE INCLUDED IN
C     THE INPUT DATASET, PRODUCING A PRINTOUT OF THE INPUT DATA
C     AND THE RESULTANT WASHING INTERVAL.
C
C     THE DATA TO BE EXAMINED FOR EACH BASE CURRENTLY CONSISTS OF:
C
C       PARAM  VARIABLES
C       -----  ---------
C       TSP    TSP,TSPT  (T-SUFFIX INDICATES THRESHOLD VALUE)
C       SO2    SO2,SO2T
C       RH     RH,RHT
C       AH     AH,AHT
C       RAIN   RAIN,RAINT
C       DIST   D2C,D2CT
C       TO SEA
C
C-----------------------------------------------------------------------C
C
C     FILE DESCRIPTIONS:
C
C       INPUT (TAPE1)
C         CONTAINS DATA FOR EACH BASE IN THE FREE-FIELD
C         FORMAT DEFINED BY THE READIN SUBROUTINE.
C
C
C       OUTPUT  (TAPE2)
C         CONTAINS ECHO OF THE INPUT DATA ALONG WITH THE RESULT OF
C         THE ALGORITHM FOR EACH BASE IN TABULAR FORM, ALONG WITH
C         APPROPRIATE LABELS.
C
C       PARAMS  (TAPE3)
C         CONTAINS THRESHOLD VALUES FOR THE DATA UNDER CONSIDERATION
C         IN THE FOLLOWING FREE-FIELD FORMAT:
C
C       TSP,SO2,PCOX,NO2,RH,HV,RAIN,D2C,DEWPT,TEMP
C
C         NOTE: NOT ALL FIELDS NEED TO BE SUPPLIED- THOSE NOT
C         USED CAN BE INDICATED BY ADJACENT COMMAS.
C
C-----------------------------------------------------------------------C
C
C     UPDATE HISTORY
C
C       04-FEB-80  MR/DJB
C         INITIAL RELEASE.
C
C       26-FEB-80  MR/DJB
C         CHANGE INPUT FORMAT TO INCLUDE ALL DATA WHETHER USED
C         BY THIS ALGORITHM OR NOT.  ALSO CHANGE OUTPUT FROM
C         TABULAR FORM TO LABELED ENTRIES FOR EACH BASE WITH
C         RESULT OF DECISION EXPRESSED BY 'A', 'B', OR 'C'
C         INSTEAD OF AN EXPLICIT INTERVAL IN DAYS.
C
C       31-MAR-80  MR/DJB
C         REMOVE EXPLICIT READS/WRITES FROM PROGRAM AND TRANSFER TO
C         COMMON DATABASE-ACCESS SUBROUTINES.  ALSO REWRITE DECISION
C         CODE TO USE LOGICAL CONDITIONS AND EXCEPTION-TESTING RATHER
C         THAN LITERALLY TRAVERSING DECISION TREE (FOR READABILITY).
C
C       12-APR-80  DJB
C         MODIFY ALGORITHM FOR ABSOLUTE HUMIDITY INSTEAD OF RELATIVE
```

```
C           HUMIDITY.
C
C         18-APR-80  DJB
C           ADD CODE FOR REPAINT AND CORROSION SEVERITY ALGORITHMS
C           EXISTING PROGRAM.
C
C         06-MAY-80  MR/DJB
C           ADD CODE TO PROCESS BOTH SETS OF THRESHOLD VALUES.
C
C----------------------------------------------------------------------C

C----------------------------------------------------------------------C
C
C      VARIABLE DECLARATIONS
C
C----------------------------------------------------------------------C

      IMPLICIT INTEGER (A-Z)

      REAL TSP(3),SO2(3),PCOX(2),NO2(3),RH,HV,RAIN,D2C,DEWPT,TEMP
      REAL TSPT(2),SO2T(2),PCOXT(2),NO2T(2),RHT(2),HVT(2),RAINT(2),D2CT(
     +2),DEWPTT(2),TEMPT(2)
      REAL AH,AHT(2),ABSHUM

      CHARACTER*30 BASENAM,STATE,COUNTY,EPAST,STATYPE
      CHARACTER*20 BLATLON,ELATLON
      CHARACTER*10 WASHINT(2),REPAINT(2),CORSEV(2),GELOC

      LOGICAL NEARSEA,SULFOX,SUSPART,WET
      LOGICAL SUNNY,OZONE,ANYPOLL
      LOGICAL EOF

      PARAMETER (PARMU=3,PRINTU=2,DATAU=1)

      COMMON/EXECMSG/DUMMY
      COMMON/PARMS/TSPT,SO2T,PCOXT,NO2T,RHT,HVT,RAINT,D2CT,DEWPTT,TEMPT
      COMMON/PARM2/AHT
      COMMON/INREC1/BASENAM,STATE,COUNTY,BLATLON,EPAST,STATYPE
      COMMON/INREC2/WBAN,TSP,SO2,PCOX,NO2
      COMMON/INREC2S/ELATLON
      COMMON/INREC3/RH,AH,HV,RAIN,D2C,DEWPT,TEMP
      COMMON/INREC3S/GELOC

      DATA BASECT/0/

C----------------------------------------------------------------------C
C
C      PROCEDURE
C
C----------------------------------------------------------------------C

C READ THRESHOLDS FROM PARAMETER FILE

      CALL READPAR(PARMU,PRINTU)

C READ DATA FOR BASE


100   CALL READIN(DATAU,EOF)
      IF (EOF) GOTO 990

C PERFORM DECISION ALGORITHMS ON BOTH SETS OF PARAMETERS

      DO 110 I=1,2

C DEFINE PREDICATES

      NEARSEA=D2C.LE.D2CT(I)
      SUSPART=TSP(3).GT.TSPT(I)
      SULFOX=SO2(3).GT.SO2T(I)
      WET=(AH.GT.AHT(I)).OR.(RAIN.GT.RAINT(I))
      SUNNY=HV.GT.HVT(I)
      OZONE=PCOX(2).GT.PCOXT(I)
      ANYPOLL=SULFOX.OR.SUSPART.OR.OZONE
```

```
C SET DEFAULT WASHING INTERVAL

      WASHINT(I)='B'

C TEST FOR EXCEPTIONS

      IF (NEARSEA) WASHINT(I)='A'

      IF (.NOT.NEARSEA.AND.SUSPART.AND.SULFOX) WASHINT(I)='A'

      IF (.NOT.NEARSEA
     +    .AND..NOT.SUSPART
     +    .AND..NOT.SULFOX
     +    .AND..NOT.WET) WASHINT(I)='C'

C SET DEFAULT REPAINT INTERVAL

      REPAINT(I)='B'

C TEST FOR EXCEPTIONS

      IF (.NOT.SUNNY
     +    .AND..NOT.OZONE
     +    .AND..NOT.SULFOX) REPAINT(I)='C'

      IF (SUNNY.AND.OZONE) REPAINT(I)='A'

      IF (SUNNY
     +    .AND..NOT.OZONE
     +    .AND.SULFOX) REPAINT(I)='A'

C DEFINE CORROSION SEVERITY

      IF (NEARSEA) CORSEV(I)='AA'

      IF (.NOT.NEARSEA
     +    .AND.WET
     +    .AND.ANYPOLL) CORSEV(I)='A'

      IF (.NOT.NEARSEA
     +    .AND.WET
     +    .AND..NOT.ANYPOLL) CORSEV(I)='B'

      IF (.NOT.NEARSEA
     +    .AND..NOT.WET
     +    .AND.ANYPOLL) CORSEV(I)='B'

      IF (.NOT.NEARSEA
     +    .AND..NOT.WET
     +    .AND..NOT.ANYPOLL) CORSEV(I)='C'

 110  CONTINUE

C PRINT RESULTS

      CALL WRITOUT(PRINTU)

      WRITE(PRINTU,9000) WASHINT,REPAINT,CORSEV

      BASECT=BASECT+1
      IF (MOD(BASECT,6).EQ.0) CALL LINES(PRINTU,16)

C LOOP BACK FOR NEXT BASE

      GOTO 100

C-----------------------------------------------------------------C
C
C       EXCEPTION PROCESSING
C
C-----------------------------------------------------------------C

C END-OF-FILE ON INPUT
```

```
990   CALL LINES(PRINTU,88)
      CALL EXIT

C------- ---------------------------------------------------------C
C
C        FORMAT STATEMENTS
C
C----------------------------------------------------------------C

9000  FORMAT ('0','WASHING INTERVAL= ',A2,' ',A2,
     +T40,'REPAINT INTERVAL= ',A2,' ',A2,
     +T80,'EXPECTED CORROSION DAMAGE= ',A2,' ',A2,
     +/'0')

      END
```

```
      SUBROUTINE READPAR(IUNIT,OUNIT)
C ---------------------------------------------------------------------C
C
C       SUBROUTINE TO READ AND PRINT PARAMETERS FROM DATA FILE
C         GIVEN BY IUNIT UPON OUNIT.
C
C       WRITTEN BY MATT RIZAI AND DAVID J. BURSIK
C         MICHIGAN STATE UNIVERSITY
C           08-APR 80
C
C ---------------------------------------------------------------------C
C
C       VARIABLE DECLARATIONS
C
C----------------------------------------------------------------------C

      IMPLICIT INTEGER (A-Z)

      REAL TSP(3),SO2(3),PCOX(2),NO2(3),RH,HV,RAIN,D2C,DEWPT,TEMP
      REAL ABSHUM,AH,AHT(2)
      REAL TSPT(2),SO2T(2),PCOXT(2),NO2T(2),RHT(2),HVT(2),RAINT(2),D2CT(
     +2),DEWPTT(2),TEMPT(2)

      CHARACTER*30 BASENAM,STATE,COUNTY,EPAST,STATYPE
      CHARACTER*20 BLATLON,ELATLON
      CHARACTER*10 WASHINT,GELOC
      CHARACTER*60 TITLE,UNDER

      LOGICAL EOF

      PARAMETER (PARMU=3,PRINTU=2,DATAU=1)

      COMMON/PARMS/TSPT,SO2T,PCOXT,NO2T,RHT,HVT,RAINT,D2CT,DEWPTT,TEMPT
      COMMON/PARM2/AHT
      COMMON/INREC1/BASENAM,STATE,COUNTY,BLATLON,EPAST,STATYPE
      COMMON/INREC2/WBAN,TSP,SO2,PCOX,NO2
      COMMON/INREC2S/ELATLON
      COMMON/INREC3/RH,AH,HV,RAIN,D2C,DEWPT,TEMP
      COMMON/INREC3S/GELOC

C----------------------------------------------------------------------C
C
C       PROCEDURE
C
C----------------------------------------------------------------------C

      REWIND IUNIT

      READ(IUNIT,*)TSPT,SO2T,PCOXT,NO2T,RHT,HVT,RAINT,D2CT,DEWPTT,TEMPT

      AHT(1)=ABSHUM(RHT(1),TEMPT(1))
      AHT(2)=ABSHUM(RHT(2),TEMPT(2))

      CALL LINES(OUNIT,10)

      TITLE='ATMOSPHERIC DATA AND SEVERITY CALCULATIONS'
      UNDER='------------------------------------------'
      WRITE(OUNIT,9010) TITLE,TITLE,UNDER,UNDER

      CALL LINES(OUNIT,13)

      WRITE(OUNIT,9000)TSPT,SO2T,PCOXT,NO2T,AHT,HVT,RAINT,D2CT,DEWPTT,TE
     +MPT

      CALL LINES(OUNIT,58)

 9000 FORMAT(10X,'THRESHOLD VALUES:'/
     +10X,'-----------------'//
     +10X,'TOTAL SUSPENDED PARTICULATES (TSP, UG/M**3):',F7.1,' ,',F7.1/
     +10X,'SULFUR OXIDES (SO2, UG/M**3):',F7.1,' ,',F7.1/
     +10X,'PHOTOCHEMICAL OXIDANTS (PCOX, UG/M**3):',F7.1,' ,',F7.1/
     +10X,'NITROGEN OXIDES (NO2, UG/M**3):',F7.1,' ,',F7-1/
     +10X,'ABSOLUTE HUMIDITY (AH, G/M**3):',F7.1,' ,',F7.1/
     +10X,'SUNLIGHT (HV, LANGLEYS):',F7.1,' ,',F7.1/
```

```
     +10X,'RAINFALL (RAIN, MM):',F7.1,' ,',F7.1/
     +10X,'DISTANCE TO SEA (D2C, KM):',F7.1,' ,',F7.1/
     +10X,'DEWPOINT (DEWPT, DEG-C):',F7.1,' ,',F7.1/
     +10X,'TEMPERATURE (TEMP, DEG-C):',F7.1,' ,',F7.1)

9010 FORMAT (T38,A60/'+',T38,A60/T38,A60/'+',T38,A60)

     RETURN
     END
```

```
      SUBROUTINE READIN(UNIT,EOF)
C---------------------------------------------------------------------C
C
C        SUBROUTINE TO READ ATMOSPHERIC DATA RECORDS FROM FILE
C          GIVEN BY UNIT, ALSO RETURNING STATE OF EOF.
C
C        WRITTEN BY MATT RIZAI AND DAVID J. BURSIK
C          MICHIGAN STATE UNIVERSITY
C            08-APR-80
C
C---------------------------------------------------------------------C
C
C        VARIABLE DECLARATIONS
C
C---------------------------------------------------------------------C

      IMPLICIT INTEGER (A-Z)

      REAL TSP(3),SO2(3),PCOX(2),NO2(3),RH,HV,RAIN,D2C,DEWPT,TEMP
      REAL ABSHUM,AH,AHT(2)
      REAL TSPT(2),SO2T(2),PCOXT(2),NO2T(2),RHT(2),HVT(2),RAINT(2),D2CT(
     +2),DEWPTT(2),TEMPT(2)

      CHARACTER*30 BASENAM,STATE,COUNTY,EPAST,STATYPE
      CHARACTER*20 BLATLON,ELATLON
      CHARACTER*10 WASHINT,GELOC
      CHARACTER*10 NA

      LOGICAL EOF

      PARAMETER (PARMU=3,PRINTU=2,DATAU=1)

      COMMON/PARMS/TSPT,SO2T,PCOXT,NO2T,RHT,HVT,RAINT,D2CT,DEWPTT,TEMPT
      COMMON/PARM2/AHT
      COMMON/INREC1/BASENAM,STATE,COUNTY,BLATLON,EPAST,STATYPE
      COMMON/INREC2/WBAN,TSP,SO2,PCOX,NO2
      COMMON/INREC2S/ELATLON
      COMMON/INREC3/RH,AH,HV,RAIN,D2C,DEWPT,TEMP
      COMMON/INREC3S/GELOC

C---------------------------------------------------------------------C
C
C        PROCEDURE
C
C---------------------------------------------------------------------C

C RESET DATA TO DEFAULT VALUES

      EOF=.FALSE.
      RH=-1.
      HV=-1.
      RAIN=-1.
      D2C=9999.99
      DEWPT=-1.
      TEMP=-1.
      NA='NA'
      BASENAM=NA
      STATE=NA
      COUNTY=NA
      EPAST=NA
      STATYPE=NA
      BLATLON=NA
      ELATLON=NA
      GELOC=NA
      WBAN=-1

      DO 10 I=1,3

        SO2(I)=-1.
        NO2(I)=-1.
        TSP(I)=-1.
        IF (I.LE.2) PCOX(I)=-1.

 10   CONTINUE
```

```
C READ RECORD

      READ(UNIT,*,END=999)BASENAM,STATE,COUNTY,BLATLON,EPAST,STATYPE,
     +          WBAN,ELATLON,TSP,SO2,PCOX,NO2,
     +          GELOC,RH,HV,RAIN,O2C,DEWPT,TEMP

      AH=ABSHUM(RH,TEMP)

      RETURN

  999 EOF=.TRUE.

      RETURN

      END
```

```
      SUBROUTINE WRITOUT(UNIT)
C--------------------------------------------------------------C
C
C       SUBROUTINE TO PRINT ATMOSPHERIC DATA RECORDS TO FILE
C         GIVEN BY UNIT.
C
C       WRITTEN BY MATT RIZAI AND DAVID J. BUKSIK
C         MICHIGAN STATE UNIVERSITY
C           08-APR-80
C
C--------------------------------------------------------------C
C
C       VARIABLE DECLARATIONS
C
C--------------------------------------------------------------C

      IMPLICIT INTEGER (A-Z)

      REAL TSP(3),SO2(3),PCOX(2),NO2(3),RH,HV,RAIN,D2C,DEWPT,TEMP
      REAL ABSHUM,AH,AHT(2)
      REAL TSPT(2),SO2T(2),PCOXT(2),NO2T(2),RHT(2),HVT(2),RAINT(2),D2CT(
     +2),DEWPTT(2),TEMPT(2)

      CHARACTER*30 BASENAM,STATE,COUNTY,EPAST,STATYPE
      CHARACTER*20 BLATLON,ELATLON
      CHARACTER*10 WASHINT,GELOC

      LOGICAL EOF

      PARAMETER (PARMU=3,PRINTU=2,DATAU=1)

      COMMON/PARMS/TSPT,SO2T,PCOXT,NO2T,RHT,HVT,RAINT,D2CT,DEWPTT,TEMPT
      COMMON/PARM2/AHT
      COMMON/INREC1/BASENAM,STATE,COUNTY,BLATLON,EPAST,STATYPE
      COMMON/INREC2/WBAN,TSP,SO2,PCOX,NO2
      COMMON/INREC2S/ELATLON
      COMMON/INREC3/RH,AH,HV,RAIN,D2C,DEWPT,TEMP
      COMMON/INREC3S/GELOC

C--------------------------------------------------------------C
C
C        PROCEDURE
C
C--------------------------------------------------------------C

       WRITE(UNIT,9000)BASENAM,STATE,COUNTY,BLATLON,WBAN,GELOC,
     +EPAST,STATYPE,ELATLON,TSP,SO2,PCOX,NO2,AH,HV,RAIN,
     +D2C,DEWPT,TEMP

 9000  FORMAT('0',A30,10X,'STATE: ',A2,3X,' COUNTY: ',A15,5X,' LOC: ',
     +A15/
     +1X,12('----------')//
     +1X,'WBAN: ',I5.5,' GELOC: ',A4,T26,'EPA STATION: ',A30,T76,
     +     'TYPE: ',A10,T100,'LOC: ',A15/
     +1X,'TSP: ',3F6.1,T26,'SO2: ',3F6.1,T52,
     +     'PCOX: ',2F6.1,T76,'NO2: ',3F6.1/
     +1X,'AH: ',F6.1,T14,'HV: ',F5.1,T26,'RAIN:  ,F7.1,T52,'D2C: ',F7.1,
     +     T76,'DEWPT: ',F5.1,T100,'TEMP: ',F5.1/
     +1X,12('----------'))

       RETURN

       END
```

```
      REAL FUNCTION ABSHUM(RH,TEMP)
C-----------------------------------------------------------------C
C
C        FUNCTION TO CONVERT RELATIVE HUMIDITY (RH, PERCENT) TO
C          ABSOLUTE HUMIDITY (G/M**3) GIVEN TEMPERATURE (TEMP, DEG-C).
C
C        WRITTEN BY DAVID J. BURSIK
C          MICHIGAN STATE UNIVERSITY
C          08-APR-80
C
C-----------------------------------------------------------------C

      REAL RH,TEMP,XLATE(69)

      INTEGER TADJ

      DATA XLATE/
     +.496,.542,.592,.646,.705,.768,.836,.909,.988,1.047,
     +1.165,1.264,1.369,1.483,1.605,1.736,1.876,2.026,2.186,2.358,
     +2.541,2.737,2.946,3.169,3.407,3.660,3.930,4.217,4.523,
     +4.847,
     +5.192,5.559,5.947,6.360,6.797,7.260,7.750,8.270,8.819,
     +9.399,10.01,10.66,11.35,12.07,12.83,13.63,14.84,15.37,16.21,
     +17.30,18.34,19.43,20.58,21.78,23.05,24.38,25.78,27.24,28.78,
     +30.38,32.07,33.83,35.68,37.61,39.63,41.75,43.96,46.26,48.67
     +/

C CONVERT TEMPERATURE TO INTEGER INDEX IN RANGE 1-69

      TADJ=IFIX(TEMP+30.5)

      IF (TADJ.LT.1) TADJ=1

      IF (TADJ.GT.69) TADJ=69

C COMPUTE ABSOLUTE HUMIDITY

      ABSHUM= (RH/100.) * XLATE(TADJ)

      RETURN
      END
```

APPENDIX C

Atmopheric Data and Severity Classifications
U.S. Air Force and Air National Guard Airbases in the Continental U.S.: Environmental Data and Corrosion Maintenance Interval Recommendations.

Listed below are threshold values for the various environmental factors used in the corrosion maintenance algorithms. Following these are the reported values for each airbase and the computed maintenance intervals. The methods used to establish the First and Second threshold values are discussed in paragraph 4e. of the main text of this Report. Values in this Appendix, the source from which they were taken, the units, and other information included in the Appendix follows.

All airbases listed on the PACER LIME Interim Severity Classification list (Appendix A) are included in this Appendix with the exception of Albrook AFB Balboa Canal Zone, Anderson AFB Guam, Howard AFB Canal Zone, Kincheloe AFB MI, and Shemya AFB AK. Lockbourne AFB has been renamed Rickenbacker AFB. Base locations and WBAN numbers were taken from the WBAN Station Numbers Master List[59] prepared at the National Climatic Center, Asheville, NC, August 1978. Geographical Location Codes, GELOC, are from AFM 300-4 Volume XII pages 12-234.002 to 12-234.145.[60]

Environmental Protection Agency, EPA, Monitoring Stations are from EPA-450/2-78-002 "Directory of Air Quality Monitoring Sites Active in 1976."[61] Station type and station location are from the same source.

Station types include:		Abbreviated as:
Commercial	:	COMM
Downtown	:	DOWNTOWN
Industrial	:	IND
Mobile	:	MOBILE
Info. not available	:	NA
Residential	:	RES
Rural	:	RURAL

Values for pollutant data are from EPA-450/2-78-002 Part II. Total Suspended Particulates (TSP) values are the first and second 24 hour maximum, and the arithmetic mean in micrograms per cubic meter. Sulfur Dioxide (SO^2) values are the first and second 24 hour maximum, and the arithmetic mean in micrograms per cubic meter. Photochemical oxidants (PCOX) as ozone values are the first and second 1 hour maximum in micrograms per cubic meter. Mean values are not available. Nitrogen Dioxide (NO^2) values are the first and second 24 hour maximum, and the arithmetic mean in micrograms per cubic meter. In cases where only the arithmetic mean was available, the mean is recorded with 0.0 listed for the two maxima.

Absolute Humidity (AH) is the product of relative humidity and the mass of water per cubic meter of water-saturated air at a given temperature.[48] Mean annual relative humidity (%) and mean annual temperature (°C) values are from USAF Environmental Technical Applications Center, "Worldwide Airfield Climatic

Data," Vols. I-VIII, 1970.[54] Dew point (DEWPT) °C values come from USAF ETAC.[54] Temperature (TEMP) °C, see Absolute Humidity above for source. Solar radiation ($h\nu$) is the mean solar radiation for July in Langleys, and values are from Baldwin, J.L., "Climates of the United States."[55] Rain data is in millimeters. See Absolute Humidity for source.

Distance to the sea (D2C), kilometers, is from U.S. Department of Commerce, "Sectional Aeronautical Charts."[57] The value 10,000 is entered if the distance is greater than 4.5 km for computational purposes.

Wherever data was not available, -1.0 is listed for numeric fields and NA for alpha fields.

Maintenance Recommendations:

WASHING INTERVAL = The first letter is the calculated interval using threshold values I. The second letter is the calculated interval using threshold values II.

REPAINT INTERVAL = Same as above.

EXPECTED CORROSION DAMAGE = Same as above.

N.B. These recommendations are based on the listed data, and their validity is subject to the accuracy and availability of such data. If more accurate or more complete data are available, they may be used directly in the Maintenance Algorithms to compute revised recommendations.

ATMOSPHERIC DATA AND SEVERITY CALCULATIONS

THRESHOLD VALUES:

```
TOTAL SUSPENDED PARTICULATES (TSP, UG/M**3):  61.0 ,  86.0
SULFUR OXIDES (SO2, UG/M**3):  43.0 ,  72.0
PHOTOCHEMICAL OXIDANTS (PCOX, UG/M**3):  36.0 ,  47.0
NITROGEN OXIDES (NO2, UG/M**3):  64.0 ,  78.0
ABSOLUTE HUMIDITY (AH, G/M**3):  7.1 ,  9.0
SUNLIGHT (HV, LANGLEYS):  599.0 ,  649.0
RAINFALL (RAIN, MM): 1250.0 , 1500.0
DISTANCE TO SEA (D2C, KM):  4.5 ,  2.0
DEWPOINT (DEWPT, DEG-C):  -1.0 ,  -1.0
TEMPERATURE (TEMP, DEG-C):  11.0 ,  13.0
```

AL ANG BIRMINGHAM STATE: AL COUNTY: JEFFERSON LOC: 03335N 08645W

WBAN: 13818 GELOC: BRKR EPA STATION: BIRMINGHAM TYPE: DOWNTOWN LOC: 03331N 08648W
TSP: 268.0 232.0 93.0 SO2: 52.0 15.0 6.0 PCOX: 298.0 298.0 NO2: 147.0 145.0 60.0
AH: 10.6 HV: 500.0 RAIN: 1346.0 D2C: 10000.0 DEWPT: 11.0 TEMP: 18.0

WASHING INTERVAL= B , B REPAINT INTERVAL= B , B EXPECTED CORROSION DAMAGE= A , A

ALTUS AFB STATE: OK COUNTY: JACKSON LOC: 03440N 09916W

WBAN: 13902 GELOC: AGGN EPA STATION: ALTUS TYPE: COMM LOC: 03438N 09920W
TSP: 142.0 128.0 67.0 SO2: -1.0 -1.0 -1.0 PCOX: -1.0 -1.0 NO2: -1.0 -1.0 -1.0
AH: 9.1 HV: 600.0 RAIN: -1.0 D2C: 10000.0 DEWPT: 10.0 TEMP: 18.0

WASHING INTERVAL= B , B REPAINT INTERVAL= B , C EXPECTED CORROSION DAMAGE= A , B

ANDREWS AFB STATE: MD COUNTY: PRINCE GEORGES LOC: 03849N 07652W

WBAN: 13705 GELOC: AJXF EPA STATION: DC TYPE: COMM LOC: 03701N 07454W
TSP: 354.0 189.0 89.0 SO2: 273.0 246.0 108.0 PCOX: 392.0 333.0 NO2: -1.0 -1.0 -1.0
AH: 7.8 HV: 500.0 RAIN: 1047.0 D2C: 10000.0 DEWPT: 10.0 TEMP: 13.0

WASHING INTERVAL= A , A REPAINT INTERVAL= B , B EXPECTED CORROSION DAMAGE= A , B

AR ANG FORT SMITH STATE: AR COUNTY: SEBASTIAN LOC: 03520N 09422W

WBAN: 03926 GELOC: HKRZ EPA STATION: FT SMITH TYPE: COMM LOC: 03523N 0[illegible]25W
TSP: 161.0 112.0 61.0 SO2: 11.0 10.0 3.0 PCOX: -1.0 -1.0 NO2: 75.0 74.0 36.0
AH: 10.2 HV: 550.0 RAIN: 1057.0 D2C: 10000.0 DEWPT: 9.0 TEMP: 17.0

WASHING INTERVAL= B , B REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= B , B

BARKSDALE AFB STATE: LA COUNTY: CADDOBOSSIER LOC: 03230N 09340W

WBAN: 13944 GELOC: AAWB EPA STATION: SHREVEPORT TYPE: COMM LOC: 03229N 09343W
TSP: 160.0 145.0 75.0 SO2: 7.0 2.0 3.0 PCOX: -1.0 -1.0 NO2: 73.0 58.0 29.0
AH: 11.3 HV: 550.0 RAIN: 1168.0 D2C: 10000.0 DEWPT: 12.0 TEMP: 19.0

WASHING INTERVAL= B , B REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= A , B

BEALE AFB STATE: CA COUNTY: SUTTER LOC: 03908N 12126W

WBAN: 93216 GELOC: BAEY EPA STATION: LIVE OAK TYPE: RES LOC: 03916N 12140W
TSP: 242.0 187.0 121.0 SO2: -1.0 -1.0 -1.0 PCOX: -1.0 -1.0 NO2: -1.0 -1.0 -1.0
AH: -.0 HV: -1.0 RAIN: -1.0 D2C: 10000.0 DEWPT: -1.0 TEMP: 0.0

WASHING INTERVAL= B , B REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= B , B

```
BERGSTROM AFB                          STATE: TX    COUNTY: TRAVIS              LOC: 03013N 09740W
------------------------------------------------------------------------------------------------------
WBAN: 13904 GELOC: BJHZ EPA STATION: AUSTIN                           TYPE: CONM             LOC: 03022N 09744W
TSP:  193.0 180.0  63.0 SO2:  146.0  76.0   6.0   PCOX:  286.0 271.0   NO2:   93.0  79.0  24.0
AH:   12.1  HV: 600.0   RAIN:   772.0               D2C: 10000.0       DEWPT:  13.0            TEMP:  21.0
------------------------------------------------------------------------------------------------------

WASHING INTERVAL= B , B             REPAINT INTERVAL= A , B             EXPECTED CORROSION DAMAGE= A , A


BLYTHVILLE AFB                         STATE: AR    COUNTY: MISSISSIPPI         LOC: 03550N 08957W
------------------------------------------------------------------------------------------------------
WBAN: 13814 GELOC: BWKR EPA STATION: BLYTHVILLE                       TYPE: CONM             LOC: 03556N 08354W
TSP:  215.0 147.0  74.0 SO2:   32.0  16.0   4.0   PCOX:   -1.0  -1.0   NO2:   74.0  64.0  34.0
AH:    9.0  HV: 550.0   RAIN:  1217.0               D2C: 10000.0       DEWPT:   9.0            TEMP:  16.0
------------------------------------------------------------------------------------------------------

WASHING INTERVAL= B , B             REPAINT INTERVAL= C , C             EXPECTED CORROSION DAMAGE= A , B


BUCKLEY ANGB DENVER                    STATE: CO    COUNTY: DENVER              LOC: 03945N 10500W
------------------------------------------------------------------------------------------------------
WBAN: 93002 GELOC: CRWU EPA STATION: DENVER                           TYPE: CONM             LOC: 03945N 10459W
TSP:  456.0 381.0 139.0 SO2:  162.0 158.0  29.0   PCOX:  329.0 292.0   NO2:  204.0 185.0  67.0
AH:    4.6  HV: 550.0   RAIN:   381.0               D2C: 10000.0       DEWPT:   2.0            TEMP:   9.0
------------------------------------------------------------------------------------------------------

WASHING INTERVAL= B , B             REPAINT INTERVAL= B , B             EXPECTED CORROSION DAMAGE= B , B


CA ANG FRESNO                          STATE: CA    COUNTY: FRESNO              LOC: 03646N 11942W
------------------------------------------------------------------------------------------------------
WBAN: 23104 GELOC: HAYW EPA STATION: FRESNO                           TYPE: CONM             LOC: 03..4N 11945W
TSP:  307.0 295.0 132.0 SO2:   12.0  12.0   3.0   PCOX:  431.0 372.0   NO2:  147.0 133.0  58.0
AH:    9.1  HV: 650.0   RAIN:   264.0               D2C: 10000.0       DEWPT:  10.0            TEMP:  17.0
------------------------------------------------------------------------------------------------------

WASHING INTERVAL= B , B             REPAINT INTERVAL= A , A             EXPECTED CORROSION DAMAGE= A , A


CA ANG OAKLAND                         STATE: CA    COUNTY: ALEMEDA             LOC: 03748N 12220W
------------------------------------------------------------------------------------------------------
WBAN: 23205 GELOC: SERH EPA STATION: OAKLAND                          TYPE: CONM             LOC: 03748N 12216W
TSP:  167.0 166.0  63.0 SO2:   12.0  11.0   4.0   PCOX:   -1.0  -1.0   NO2:  243.0 194.0  60.0
AH:    8.8  HV: 650.0   RAIN:   439.0               D2C:       .5      DEWPT:   8.0            TEMP:  14.0
------------------------------------------------------------------------------------------------------

WASHING INTERVAL= A , A             REPAINT INTERVAL= B , B             EXPECTED CORROSION DAMAGE= AA, AA


CA ANG VAN NUYS                        STATE: CA    COUNTY: LOS ANGELES         LOC: 03413N 11830W
------------------------------------------------------------------------------------------------------
WBAN: 23130 GELOC: XTBT EPA STATION: LOS ANGELES                      TYPE: CONM             LOC: 03403N 11815W
TSP:  240.0 235.0 109.0 SO2:  195.0 194.0  52.0   PCOX:   -1.0  -1.0   NO2:  349.0 279.0 135.0
AH:    9.3  HV: 650.0   RAIN:   287.0               D2C: 10000.0       DEWPT:  10.0            TEMP:  17.0
------------------------------------------------------------------------------------------------------

WASHING INTERVAL= A , B             REPAINT INTERVAL= A , B             EXPECTED CORROSION DAMAGE= A , A
```

```
CANNON AFB                         STATE: NM    COUNTY: CURREY            LOC: 03425N 10305W
----------------------------------------------------------------------------------------------------
WBAN: 23077 GELOC: CZQZ EPA STATION: CLOVIS                      TYPE: COMM            LOC: 03424N 10312W
TSP:  253.0 241.0  98.0 SO2:   -1.0  -1.0  -1.0   PCOX:   -1.0  -1.0   NO2:   -1.0  -1.0  -1.0
AH:     6.2  HV: 600.0  RAIN:   384.0             B2C: 10000.0         DEWPT:   2.0            TEMP:  14.0
----------------------------------------------------------------------------------------------------

WASHING INTERVAL= B , B            REPAINT INTERVAL= B , C            EXPECTED CORROSION DAMAGE= B , B


CARSWELL AFB                       STATE: TX    COUNTY: TARRANT           LOC: 03246N 09725W
----------------------------------------------------------------------------------------------------
WBAN: 13911 GELOC: DBPF EPA STATION: FTWORTH                     TYPE: RES             LOC: 03248N 09721W
TSP:  141.0 108.0  60.0 SO2:    5.0   7.0   3.0   PCOX:  363.0 353.0   NO2:  244.0 244.0  25.0
AH:    10.1  HV: 600.0  RAIN:   772.0             B2C: 10000.0         DEWPT:  11.0            TEMP:  19.0
----------------------------------------------------------------------------------------------------

WASHING INTERVAL= B , B            REPAINT INTERVAL= A , B            EXPECTED CORROSION DAMAGE= A , A


CASTLE AFB                         STATE: CA    COUNTY: MERCED            LOC: 03723N 12034W
----------------------------------------------------------------------------------------------------
WBAN: 23202 GELOC: MESR EPA STATION: MERCED                      TYPE: COMM            LOC: 03718N 12030W
TSP:  293.0 266.0 132.0 SO2:   -1.0  -1.0  -1.0   PCOX:  274.0 274.0   NO2:   -1.0  -1.0  -1.0
AH:     9.1  HV: 650.0  RAIN:   279.0             B2C: 10000.0         DEWPT:   8.0            TEMP:  17.0
----------------------------------------------------------------------------------------------------

WASHING INTERVAL= B , B            REPAINT INTERVAL= A , A            EXPECTED CORROSION DAMAGE= A , A


CHARLESTON AFB                     STATE: SC    COUNTY: CHARLESTON        LOC: 03254N 08002W
----------------------------------------------------------------------------------------------------
WBAN: 03857 GELOC: BKFX EPA STATION: CHARLESTON                  TYPE: COMM            LOC: 03247N 08000W
TSP:  124.0  99.0  53.0 SO2:   35.0  35.0   5.0   PCOX:   -1.0  -1.0   NO2:   99.0  91.0  44.0
AH:    12.3  HV: 500.0  RAIN:  1196.0             B2C       4.0        DEWPT:  13.0            TEMP:  19.0
----------------------------------------------------------------------------------------------------

WASHING INTERVAL= A , B            REPAINT INTERVAL= C , C            EXPECTED CORROSION DAMAGE= AA, B


COLUMBUS AFB                       STATE: MS    COUNTY: LOWNDES           LOC: 03339N 08827W
----------------------------------------------------------------------------------------------------
WBAN: 13825 GELOC: EEPZ EPA STATION: COLUMBUS                    TYPE: RES             LOC: 03329N 08825W
TSP:  123.0 116.0  48.0 SO2:   -1.0  -1.0  -1.0   PCOX:   -1.0  -1.0   NO2:   -1.0  -1.0  -1.0
AH:    10.5  HV: 500.0  RAIN:  1245.0             B2C: 10000.0         DEWPT:  11.0            TEMP:  17.0
----------------------------------------------------------------------------------------------------

WASHING INTERVAL= B , B            REPAINT INTERVAL= C , C            EXPECTED CORROSION DAMAGE= B , B


CRAIG AFB                          STATE: AL    COUNTY: DALLAS            LOC: 03220N 08659W
----------------------------------------------------------------------------------------------------
WBAN: 13850 GELOC: EVMB EPA STATION: SELMA                       TYPE: COMM            LOC: 03224N 08701W
TSP:  120.0 117.0  73.0 SO2:   -1.0  -1.0  -1.0   PCOX:   -1.0  -1.0   NO2:   -1.0  -1.0  -1.0
AH:    11.3  HV: 509.0  RAIN:  1298.0             B2C: 10000.0         DEWPT:  13.0            TEMP:  19.0
----------------------------------------------------------------------------------------------------

WASHING INTERVAL= B , B            REPAINT INTERVAL= C , C            EXPECTED CORROSION DAMAGE= A , B
```

CT ANG BRADLEY STATE: CT COUNTY: HARTFORD LOC: 04156N 07241W

WBAN: 14721 GELOC: CEXT EPA STATION: EAST WINDSOR TYPE: IND LOC: 04155N 07237W
TSP: 144.0 115.0 75.0 SO2: 50.0 29.0 12.0 PCOX: -1.0 -1.0 NO2: 123.0 98.0 60.0
AH: 6.3 HV: 450.0 RAIN: 1095.0 B2C: 10000.0 DEWPT: 3.0 TEMP: 10.0

WASHING INTERVAL= B , C REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= B , C

DAVIS MONTHAN AFB STATE: AZ COUNTY: PIMA LOC: 03210N 11053W

WBAN: 23109 GELOC: FMNV EPA STATION: TUCSON TYPE: COMM LOC: 03212N 11052W
TSP: 264.0 151.0 78.0 SO2: -1.0 -1.0 -1.0 PCOX: -1.0 -1.0 NO2: -1.0 -1.0 -1.0
AH: 7.0 HV: 600.0 RAIN: 249.0 B2C: 10000.0 DEWPT: 3.0 TEMP: 21.0

WASHING INTERVAL= B , C REPAINT INTERVAL= B , C EXPECTED CORROSION DAMAGE= B , C

DE ANG WILMINGTON STATE: DE COUNTY: NEW CASTLE LOC: 03941N 07536W

WBAN: 13708 GELOC: ZBBU EPA STATION: WILMINGTON TYPE: COMM LOC: 03944N 07533W
TSP: 165.0 131.0 92.0 SO2: 143.0 116.0 44.0 PCOX: -1.0 -1.0 NO2: -1.0 -1.0 -1.0
AH: 8.1 HV: 500.0 RAIN: 1113.0 B2C: 2.8 DEWPT: 7.0 TEMP: 13.0

WASHING INTERVAL= A , B REPAINT INTERVAL= B , C EXPECTED CORROSION DAMAGE= AA, B

DOBBINS AFB STATE: GA COUNTY: COBB LOC: 03355N 08431W

WBAN: 13864 GELOC: FGWB EPA STATION: MARIETTA TYPE: COMM LOC: 03357N 08432W
TSP: 77.0 76.0 43.0 SO2: -1.0 -1.0 -1.0 PCOX: -1.0 -1.0 NO2: -1.0 -1.0 -1.0
AH: 9.8 HV: 500.0 RAIN: 1171.0 B2C: 10000.0 DEWPT: 10.0 TEMP: 16.0

WASHING INTERVAL= B , B REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= B , B

DOVER AFB STATE: DE COUNTY: KENT LOC: 03908N 07528W

WBAN: 13707 GELOC: FJXT EPA STATION: DOVER TYPE: COMM LOC: 03909N 07530W
TSP: 154.0 139.0 67.0 SO2: 15.0 15.0 6.0 PCOX: -1.0 -1.0 NO2: -1.0 -1.0 -1.0
AH: 8.3 HV: 500.0 RAIN: 1128.0 B2C: 3.5 DEWPT: 8.0 TEMP: 13.0

WASHING INTERVAL= A , C REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= AA, C

DULUTH ANG STATE: MN COUNTY: ST LOUIS LOC: 04650N 09211W

WBAN: 14913 GELOC: FMKN EPA STATION: DULUTH TYPE: COMM LOC: 04647N 09206W
TSP: 180.0 101.0 43.0 SO2: 11.0 10.0 6.0 PCOX: -1.0 -1.0 NO2: 82.0 45.0 29.0
AH: 4.7 HV: 550.0 RAIN: 757.0 B2C: 10000.0 DEWPT: 1.0 TEMP: 4.0

WASHING INTERVAL= C , C REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= C , C

```
DYESS AFB                          STATE: TX    COUNTY: TAYLOR           LOC: 03226N 09951W
-----------------------------------------------------------------------------------------------
WBAN: 13910 GELOC: FNWZ EPA STATION: ABILENE                    TYPE: RES           LOC: 03227N 09940W
TSP:  137.0 133.0  60.0 SO2:    2.0   2.0   3.0   PCOX:   -1.0  -1.0    NO2:   57.0  46.0  21.0
AH:     8.8  HV: 600.0  RAIN:   643.0              D2C: 10000.0         DEWPT:   8.0          TEMP:  18.0
-----------------------------------------------------------------------------------------------
WASHING INTERVAL= B , C          REPAINT INTERVAL= B , C          EXPECTED CORROSION DAMAGE= B , C

EDWARDS AFB                        STATE: CA    COUNTY: KERN             LOC: 03454N 11752W
-----------------------------------------------------------------------------------------------
WBAN: 23114 GELOC: FSPM EPA STATION: BAKERSFIELD                TYPE: COMM          LOC: 03521N 11901W
TSP:  416.0 409.0 171.0 SO2:   -1.0  -1.0  -1.0   PCOX:   -1.0  -1.0    NO2:   -1.0  -1.0  -1.0
AH:     6.7  HV: 700.0  RAIN:    89.0              D2C: 10000.0         DEWPT:   2.0          TEMP:  17.0
-----------------------------------------------------------------------------------------------
WASHING INTERVAL= B , B          REPAINT INTERVAL= B , B          EXPECTED CORROSION DAMAGE= B , B

EGLIN                              STATE: FL    COUNTY: ESCAMBIA         LOC: 03040N 08622W
-----------------------------------------------------------------------------------------------
WBAN: 03842 GELOC: FTFA EPA STATION: PENSACOLA                  TYPE: COMM          LOC: 03032N 08712W
TSP:  183.0 103.0  45.0 SO2:  202.0 179.0  26.0   PCOX:  314.0 306.0    NO2:  110.0  64.0  32.0
AH:    -.0   HV:  -1.0  RAIN:    -1.0              D2C:      2.0        DEWPT:  -1.0          TEMP:   0.0
-----------------------------------------------------------------------------------------------
WASHING INTERVAL= A , A          REPAINT INTERVAL= B , B          EXPECTED CORROSION DAMAGE= AA, AA

EIELSON AFB                        STATE: AK    COUNTY: FAIRBANKS        LOC: 06440N 14706W
-----------------------------------------------------------------------------------------------
WBAN: 26407 GELOC: FTGW EPA STATION: FAIRBANKS                  TYPE: COMM          LOC: 06450N 14743W
TSP:  284.0 251.0 123.0 SO2:   22.0  21.0  12.0   PCOX:   -1.0  -1.0    NO2:  110.0 103.0  59.0
AH:     6.4  HV:  -1.0  RAIN:   376.0              D2C: 10000.0         DEWPT:   8.0          TEMP:   9.0
-----------------------------------------------------------------------------------------------
WASHING INTERVAL= B , B          REPAINT INTERVAL= C , C          EXPECTED CORROSION DAMAGE= B , B

ELLSWORTH AFB                      STATE: SD    COUNTY: MEADE            LOC: 04406N 10306W
-----------------------------------------------------------------------------------------------
WBAN: 24006 GELOC: FXBN EPA STATION: RAPID CITY                 TYPE: COMM          LOC: 04405N 10315W
TSP:  334.0 259.0  95.0 SO2:    2.0   2.0   3.0   PCOX:   -1.0  -1.0    NO2:   -1.0  -1.0  -1.0
AH:     4.9  HV: 600.0  RAIN:   389.0              D2C: 10000.0         DEWPT:   0.0          TEMP:   8.0
-----------------------------------------------------------------------------------------------
WASHING INTERVAL= B , B          REPAINT INTERVAL= B , C          EXPECTED CORROSION DAMAGE= B , B

ELMENDORF AFB                      STATE: AK    COUNTY: ANCHORAGE        LOC: 06115N 14948W
-----------------------------------------------------------------------------------------------
WBAN: 26401 GELOC: FXSR EPA STATION: ANCHORAGE                  TYPE: IND           LOC: 06115N 14659W
TSP:   -1.0  -1.0  -1.0 SO2:   32.0  25.0   7.0   PCOX:   -1.0  -1.0    NO2:   -1.0  -1.0  -1.0
AH:     4.1  HV:  -1.0  RAIN:   430.0              D2C:      1.0        DEWPT:   3.0          TEMP:   2.0
-----------------------------------------------------------------------------------------------
WASHING INTERVAL= A , A          REPAINT INTERVAL= C , C          EXPECTED CORROSION DAMAGE= AA, AA
```

```
ENGLAND AFB                        STATE: LA    COUNTY: RAPIDES            LOC: 03120N 09233W
-------------------------------------------------------------------------------------------------
WBAN: 13934 GELOC: GAMH EPA STATION: ALEXANDRIA                      TYPE: COMM          LOC: 03117N 09228W
TSP:   96.0  81.0  41.0 SO2:   10.0   8.0   3.0   PCOX:   -1.0  -1.0   NO2:   54.0  53.0  23.0
AH:   11.7  HV: 500.0   RAIN:  1379.0             D2C: 10000.0         DEWPT:  13.0        TEMP:  19.0
-------------------------------------------------------------------------------------------------
WASHING INTERVAL= B , B           REPAINT INTERVAL= C , C           EXPECTED CORROSION DAMAGE= B , B

FAIRCHILD AFB                      STATE: WA    COUNTY: SPOKANE            LOC: 04738N 11739W
-------------------------------------------------------------------------------------------------
WBAN: 24114 GELOC: GJKZ EPA STATION: SPOKANE                         TYPE: RES           LOC: 04740N 11725W
TSP:  235.0 228.0  99.0 SO2:  108.0 107.0  25.0   PCOX:  176.0 137.0   NO2:    0.0   0.0  48.0
AH:    5.5  HV: 650.0   RAIN:   363.0             D2C: 10000.0         DEWPT:   1.0        TEMP:   8.0
-------------------------------------------------------------------------------------------------
WASHING INTERVAL= B , B           REPAINT INTERVAL= A , A           EXPECTED CORROSION DAMAGE= B , B

FL ANG JACKSONVILLE                STATE: FL    COUNTY: DUVAL              LOC: 03014N 08141W
-------------------------------------------------------------------------------------------------
WBAN: 93837 GELOC: LSGA EPA STATION: JACKSONVILLE                    TYPE: IND           LOC: 03024N 08134W
TSP:   68.0  68.0  33.0 SO2:  207.0 141.0  28.0   PCOX:   -1.0  -1.0   NO2:   50.0  35.0  23.0
AH:   14.4  HV: 500.0   RAIN:  1168.0             D2C:        .5       DEWPT:  16.0        TEMP:  22.0
-------------------------------------------------------------------------------------------------
WASHING INTERVAL= A , A           REPAINT INTERVAL= C , C           EXPECTED CORROSION DAMAGE= AA, AA

FORBES AFB                         STATE: KS    COUNTY: SHAWNEE            LOC: 03857N 09540W
-------------------------------------------------------------------------------------------------
WBAN: 13920 GELOC: GUQE EPA STATION: TOPEKA                          TYPE: RES           LOC: 03902N 09541W
TSP:  142.0 134.0  70.0 SO2:    9.0   9.0   3.0   PCOX:   -1.0  -1.0   NO2:   74.0  43.0  24.0
AH:    7.6  HV: 550.0   RAIN:   755.0             D2C: 10000.0         DEWPT:   6.0        TEMP:  13.0
-------------------------------------------------------------------------------------------------
WASHING INTERVAL= B , C           REPAINT INTERVAL= C , C           EXPECTED CORROSION DAMAGE= A , C

FRANCIS E WARREN AFB               STATE: WY    COUNTY: LARAMIE            LOC: 04109N 10448W
-------------------------------------------------------------------------------------------------
WBAN: 94006 GELOC: GYHQ EPA STATION: CHEYENNE                        TYPE: COMM          LOC: 04108N 10449W
TSP:   88.0  78.0  34.0 SO2:   18.0  16.0   4.0   PCOX:   -1.0  -1.0   NO2:   -1.0  -1.0  -1.0
AH:    4.5  HV: 600.0   RAIN:   386.0             D2C: 10000.0         DEWPT:   3.0        TEMP:   8.0
-------------------------------------------------------------------------------------------------
WASHING INTERVAL= C , C           REPAINT INTERVAL= B , C           EXPECTED CORROSION DAMAGE= C , C

GA ANG TRAVIS                      STATE: GA    COUNTY: CHATHAM            LOC: 03208N 08112W
-------------------------------------------------------------------------------------------------
WBAN: 03822 GELOC: XDBN EPA STATION: SAVANNAH                        TYPE: COMM          LOC: 03205N 08106W
TSP:  158.0 119.0  64.0 SO2:   10.0   8.0   3.0   PCOX:   -1.0  -1.0   NO2:   84.0  63.0  36.0
AH:     -.0 HV: 500.0   RAIN:    -1.0             D2C: 10000.0         DEWPT:  -1.0        TEMP:   0.0
-------------------------------------------------------------------------------------------------
WASHING INTERVAL= B , C           REPAINT INTERVAL= C , C           EXPECTED CORROSION DAMAGE= B , C
```

GEORGE AFB STATE: CA COUNTY: SAN BERNARDINO LOC: 03435N 11723W

WBAN: 23131 GELOC: HUUA EPA STATION: VICTORVILLE TYPE: CONM LOC: 03432N 11718W
TSP: 160.0 133.0 104.0 SO2: -1.0 -1.0 -1.0 PCOX: -1.0 -1.0 NO2: 0.0 0.0 34.0
AH: 6.2 HV: 650.0 RAIN: 86.0 D2C: 10000.0 DEWPT: 1.0 TEMP: 17.0

WASHING INTERVAL= B , B REPAINT INTERVAL= B , B EXPECTED CORROSION DAMAGE= B , B

GOODFELLOW AFB STATE: TX COUNTY: TOM GREEN LOC: 03124N 10024W

WBAN: 23017 GELOC: JCGU EPA STATION: SAN ANGELO TYPE: CONM LOC: 03128N 10026W
TSP: 107.0 51.0 55.0 SO2: 2.0 2.0 3.0 PCOX: -1.0 -1.0 NO2: 36.0 34.0 14.0
AH: 2.6 HV: 600.0 RAIN: 376.0 D2C: 10000.0 DEWPT: -1.0 TEMP: 0.0

WASHING INTERVAL= C , C REPAINT INTERVAL= B , C EXPECTED CORROSION DAMAGE= C , C

GRAND FORKS AFB STATE: ND COUNTY: GRAND FORKS LOC: 04757N 09724W

WBAN: 94925 GELOC: JFSD EPA STATION: FARGO TYPE: CONM LOC: 04652N 09647W
TSP: 125.0 123.0 67.0 SO2: 2.0 2.0 5.0 PCOX: -1.0 -1.0 NO2: 56.0 56.0 53.0
AH: 4.5 HV: 550.0 RAIN: [illegible]7.0 D2C: 10000.0 DEWPT: 2.0 TEMP: 4.0

WASHING INTERVAL= B , C REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= B , C

GRIFFISS AFB STATE: NY COUNTY: ONEIDA LOC: 04314N 07524W

WBAN: 14717 GELOC: JREZ EPA STATION: ROME TYPE: CONM LOC: 04313N 075[illegible]W
TSP: 163.0 105.0 59.0 SO2: 57.0 55.0 9.0 PCOX: -1.0 -1.0 NO2: -1.0 -1.0 -1.0
AH: 6.2 HV: 450.0 RAIN: 1100.0 D2C: 10000.0 DEWPT: 4.0 TEMP: 8.0

WASHING INTERVAL= C , C REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= C , C

GRISSOM AFB STATE: IN COUNTY: MIAMI LOC: 04039N 08609W

WBAN: 94833 GELOC: CTGC EPA STATION: KOKOMO TYPE: CONM LOC: 04030N 08607W
TSP: 195.0 114.0 66.0 SO2: 74.0 51.0 15.0 PCOX: -1.0 -1.0 NO2: 56.0 40.0 28.0
AH: 7.0 HV: 500.0 RAIN: 1100.0 D2C: 10000.0 DEWPT: 5.0 TEMP: 10.0

WASHING INTERVAL= B , C REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= B , C

HAMILTON AFB STATE: CA COUNTY: MARIN LOC: 03804N 12230W

WBAN: 23211 GELOC: JYZJ EPA STATION: SAN RAFAEL TYPE: CONM LOC: 03758N 12231W
TSP: 170.0 111.0 48.0 SO2: -1.0 -1.0 -1.0 PCOX: -1.0 -1.0 NO2: 0.0 0.0 54.0
AH: 9.1 HV: 650.0 RAIN: 658.0 D2C: 10000.0 DEWPT: 9.0 TEMP: 14.0

WASHING INTERVAL= B , B REPAINT INTERVAL= B , B EXPECTED CORROSION DAMAGE= B , B

HANSCOM AFB   STATE: MA   COUNTY: MIDDLESEX   LOC: 04228N 07117W

WBAN: 14702 GELOC: BCNZ EPA STATION: WOBURN   TYPE: COMM   LOC: 04229N 07109W
TSP: 129.0 90.0 49.0 SO2: 18.0 13.0   8.0   PCOX: -1.0 -1.0   NO2: 85.0 64.0 35.0
AH: 6.3 HV: 500.0 RAIN: 1199.0   B2C: 10000.0   DEWPT: 4.0   TEMP: 9.0

WASHING INTERVAL= C , C   REPAINT INTERVAL= C , C   EXPECTED CORROSION DAMAGE= C , C

HICKAM AFB   STATE: HI   COUNTY: HONOLULU   LOC: 02120N 15757W

WBAN: 22504 GELOC: KNNB EPA STATION: HONOLULU   TYPE: COMM   LOC: 02119N 15753W
TSP: 113.0 95.0 52.0 SO2: 32.0 12.0   3.0   PCOX: -1.0 -1.0   NO2: 67.0 64.0 37.0
AH: 16.1 HV: -1.0 RAIN: 467.0   D2C: .5   DEWPT: 18.0   TEMP: 25.0

WASHING INTERVAL= A , A   REPAINT INTERVAL= C , C   EXPECTED CORROSION DAMAGE= AA, AA

HILL AFB   STATE: UT   COUNTY: WEBER   LOC: 04107N 11158W

WBAN: 24101 GELOC: KRSM EPA STATION: OGDEN   TYPE: COMM   LOC: 04113N 11158W
TSP: 320.0 301.0 102.0 SO2: 81.0 75.0 21.0   PCOX: -1.0 -1.0   NO2:   0.0   0.0 48.0
AH: 5.2 HV: 600.0 RAIN: 427.0   B2C: 10000.0   DEWPT: 1.0   TEMP: 11.0

WASHING INTERVAL= B , B   REPAINT INTERVAL= B , C   EXPECTED CORROSION DAMAGE= B , B

HOLLOMAN AFB   STATE: NM   COUNTY: OTERO   LOC: 03251N 10606W

WBAN: 23002 GELOC: KWRD EPA STATION: ALAMOGORDO   TYPE: COMM   LOC: 03254N 10657W
TSP: 478.0 246.0 70.0 SO2: -1.0 -1.0 -1.0   PCOX: -1.0 -1.0   NO2: -1.0 -1.0 -1.0
AH: 6.1 HV: 650.0 RAIN: 170.0   D2C: 10000.0   DEWPT: 2.0   TEMP: 17.0

WASHING INTERVAL= B , C   REPAINT INTERVAL= B , B   EXPECTED CORROSION DAMAGE= B , C

HOMESTEAD AFB   STATE: FL   COUNTY: DADE   LOC: 02529N 08024W

WBAN: 12826 GELOC: KYJL EPA STATION: HOMESTEAD   TYPE: COMM   LOC: 02528N 08029W
TSP: 78.0 72.0 42.0 SO2: 35.0 20.0   7.0   PCOX: -1.0 -1.0   NO2: 40.0 36.0 16.0
AH: 15.6 HV: 500.0 RAIN: 1607.0   B2C: 2.5   DEWPT: 19.0   TEMP: 23.0

WASHING INTERVAL= A , B   REPAINT INTERVAL= C , C   EXPECTED CORROSION DAMAGE= AA, B

IA ANG DES MOINES   STATE: IA   COUNTY: POLK   LOC: 04135N 09337W

WBAN: 14967 GELOC: FFAN EPA STATION: DES MOINES   TYPE: IND   LOC: 04135N 09336W
TSP: 173.0 158.0 86.0 SO2: 97.0 93.0   6.0   PCOX: -1.0 -1.0   NO2: 47.0 45.0 26.0
AH: 6.6 HV: 500.0 RAIN: 796.0   B2C: 10000.0   DEWPT: 4.0   TEMP: 10.0

WASHING INTERVAL= B , C   REPAINT INTERVAL= C , C   EXPECTED CORROSION DAMAGE= B , C

```
IA ANG SIOUX CITY                STATE: IA    COUNTY: WOODBURY          LOC: 04224N 09623W
------------------------------------------------------------------------------------------------
WBAN: 14906 GELOC: VSSB EPA STATION: SIOUX CITY                  TYPE: COMM          LOC: 04230N 09024W
TSP:  190.0 142.0  72.0 SO2:   12.0  12.0   8.0   PCOX:   -1.0  -1.0   NO2:  -1.0  -1.0  -1.0
AH:    6.3  HV: 550.0   RAIN:   670.0              D2C: 10000.0        DEWPT:   3.0          TEMP:   9.0
------------------------------------------------------------------------------------------------
WASHING INTERVAL= B , C          REPAINT INTERVAL= C , C          EXPECTED CORROSION DAMAGE= B , C


ID ANG BOISE                     STATE: ID    COUNTY: ADA               LOC: 04334N 11613W
------------------------------------------------------------------------------------------------
WBAN: 24131 GELOC: BXRH EPA STATION: BOISE                       TYPE: COMM          LOC: 04337N 11612W
TSP:   -1.0  -1.0  -1.0 SO2:   51.0  49.0  18.0   PCOX:   -1.0  -1.0   NO2:  96.0  83.0  50.0
AH:    5.7  HV: 650.0   RAIN:   340.0              D2C: 10000.0        DEWPT:   1.0          TEMP:  11.0
------------------------------------------------------------------------------------------------
WASHING INTERVAL= C , C          REPAINT INTERVAL= B , B          EXPECTED CORROSION DAMAGE= C , C


IL ANG CAPITAL                   STATE: IL    COUNTY: SANGAMON          LOC: 03950N 08940W
------------------------------------------------------------------------------------------------
WBAN: 93822 GELOC: BCFT EPA STATION: SPRINGFIELD                 TYPE: COMM          LOC: 03948N 08939W
TSP:  315.0 207.6  95.0 SO2:  352.0 131.0  27.0   PCOX:  214.0 208.0   NO2:  60.0  53.0  30.0
AH:    7.5  HV: 500.0   RAIN:   854.0              D2C: 10000.0        DEWPT:   6.0          TEMP:  12.0
------------------------------------------------------------------------------------------------
WASHING INTERVAL= B , B          REPAINT INTERVAL= B , B          EXPECTED CORROSION DAMAGE= A , B


IL ANG OHARE                     STATE: IL    COUNTY: COOK              LOC: 04159N 08754W
------------------------------------------------------------------------------------------------
WBAN: 94846 GELOC: BPWB EPA STATION: CHICAGO                     TYPE: RES           LOC: 04159N 08747W
TSP:  451.0 259.0  74.0 SO2:  133.0  96.0  16.0   PCOX:   -1.0  -1.0   NO2: 350.0 184.0  72.0
AH:    6.3  HV: 500.0   RAIN:   746.0              D2C: 10000.0        DEWPT:   3.0          TEMP:   9.0
------------------------------------------------------------------------------------------------
WASHING INTERVAL= B , C          REPAINT INTERVAL= C , C          EXPECTED CORROSION DAMAGE= B , C


IL ANG PEORIA                    STATE: IL    COUNTY: PEORIA            LOC: 04040N 08941W
------------------------------------------------------------------------------------------------
WBAN: 14842 GELOC: 1BBT EPA STATION: PEORIA                      TYPE: COMM          LOC: 04042N 08935W
TSP:   -1.0  -1.0  -1.0 SO2:  523.0 485.0 140.0   PCOX:  208.0 171.0   NO2:  -1.0  -1.0  -1.0
AH:    7.0  HV: 500.0   RAIN:   979.0              D2C: 10000.0        DEWPT:   5.0          TEMP:  11.0
------------------------------------------------------------------------------------------------
WASHING INTERVAL= B , B          REPAINT INTERVAL= B , B          EXPECTED CORROSION DAMAGE= B , B


IN ANG BAER                      STATE: IN    COUNTY: ALLEN             LOC: 04101N 08511W
------------------------------------------------------------------------------------------------
WBAN: 14805 GELOC: ATQZ EPA STATION: FT WAYNE                    TYPE: RES           LOC: 04104N 08508W
TSP:  191.0 156.0  68.0 SO2:   94.0  84.0  25.0   PCOX:   -1.0  -1.0   NO2:  66.0  65.0  41.0
AH:    6.9  HV: 550.0   RAIN:   973.0              D2C: 10000.0        DEWPT:   5.0          TEMP:  10.0
------------------------------------------------------------------------------------------------
WASHING INTERVAL= B , C          REPAINT INTERVAL= C , C          EXPECTED CORROSION DAMAGE= B , C
```

IN ANG HULMAN STATE: IN COUNTY: VIGO LOC: 03927N 08717W

WBAN: 03868 GELOC: LDXF EPA STATION: TERRE HAUTE TYPE: COMM LOC: 03928N 08724W
TSP: 150.0 144.0 75.0 SO2: 107.0 97.0 20.0 PCOX: -1.0 -1.0 NO2: 88.0 86.0 32.0
AH: 7.7 HV: 550.0 RAIN: 1016.0 D2C: 10000.0 DEWPT: 6.0 TEMP: 12.0

WASHING INTERVAL= B , C REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= A , C

K I SAWYER AFB STATE: MI COUNTY: MARQUETTE LOC: 04621N 08724W

WBAN: 14851 GELOC: LWRC EPA STATION: MARQUETTE TYPE: NA LOC: 04632N 08723W
TSP: 231.0 114.0 45.0 SO2: 62.0 57.0 18.0 PCOX: 372.0 294.0 NO2: 61.0 54.0 27.0
AH: 4.8 HV: 500.0 RAIN: 790.0 D2C: 10000.0 DEWPT: 1.0 TEMP: 4.0

WASHING INTERVAL= C , C REPAINT INTERVAL= B , B EXPECTED CORROSION DAMAGE= B , B

KEESLER AFB STATE: MS COUNTY: JACKSON LOC: 03025N 08855W

WBAN: 13820 GELOC: MAHG EPA STATION: BILOXI TYPE: RES LOC: 03024N 08852W
TSP: 103.0 76.0 45.0 SO2: 45.0 41.0 8.0 PCOX: -1.0 -1.0 NO2: -1.0 -1.0 -1.0
AH: 12.8 HV: 500.0 RAIN: 1527.0 D2C: 1.0 DEWPT: 15.0 TEMP: 20.0

WASHING INTERVAL= A , A REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= AA, AA

KELL FLD STATE: TX COUNTY: WICHITA LOC: 03358N 09850W

WBAN: 13966 GELOC: YXWD EPA STATION: WICHITA FALLS TYPE: COMM LOC: 03354N 09830W
TSP: 201.0 161.0 71.0 SO2: 2.0 2.0 3.0 PCOX: -1.0 -1.0 NO2: 53.0 49.0 21.0
AH: 8.9 HV: 600.0 RAIN: 684.0 D2C: 10000.0 DEWPT: 8.0 TEMP: 18.0

WASHING INTERVAL= B , C REPAINT INTERVAL= B , C EXPECTED CORROSION DAMAGE= A , C

KELLY AFB STATE: TX COUNTY: BEXAR LOC: 02923N 09035W

WBAN: 12909 GELOC: MRPB EPA STATION: SAN ANTONIO TYPE: COMM LOC: 02925N 09829W
TSP: 315.0 130.0 68.0 SO2: 14.0 7.0 3.0 PCOX: -1.0 -1.0 NO2: 82.0 73.0 29.0
AH: 11.9 HV: 600.0 RAIN: 592.0 D2C: 10000.0 DEWPT: 13.0 TEMP: 21.0

WASHING INTERVAL= B , B REPAINT INTERVAL= B , C EXPECTED CORROSION DAMAGE= A , B

KINGSLEY FLD STATE: OR COUNTY: KLAMATH LOC: 04210N 12144W

WBAN: 94236 GELOC: MFWN EPA STATION: KLAMATH FALLS TYPE: COMM LOC: 04212N 12144W
TSP: 200.0 190.0 77.0 SO2: 65.0 15.0 14.0 PCOX: -1.0 -1.0 NO2: -1.0 -1.0 -1.0
AH: 5.6 HV: 650.0 RAIN: 338.0 D2C: 10000.0 DEWPT: 0.0 TEMP: 9.0

WASHING INTERVAL= B , C REPAINT INTERVAL= B , B EXPECTED CORROSION DAMAGE= B , C

```
KIRTLAND AFB                          STATE: NM    COUNTY: BERNILILLO         LOC: 03503N 10636W
------------------------------------------------------------------------------------------------

WBAN: 23004 GELOC: NMMV EPA STATION: ALBUQUERQUE                    TYPE: COMM             LOC: 03504N 10634W
TSP:  197.0 169.0  89.0 SO2:   28.0  26.0  18.0   PCOX:   -1.0  -1.0   NO2:   55.0  46.0  30.0
AH:     5.4  HV: 650.0   RAIN:   153.0              D2C: 10000.0         DEWPT:   0.0             TEMP:  14.0
------------------------------------------------------------------------------------------------

WASHING INTERVAL= B , B            REPAINT INTERVAL= B , B             EXPECTED CORROSION DAMAGE= B , B

KY ANG LOUISVILLE                     STATE: KY    COUNTY: JEFFERSON          LOC: 03815N 08545W
------------------------------------------------------------------------------------------------

WBAN: 93893 GELOC: NSQM EPA STATION: LOUISVILLE                     TYPE: COMM             LOC: 03815N 08545W
TSP:  211.0 175.0  96.0 SO2:  335.0 259.0  40.0   PCOX:  176.0 167.0   NO2:  303.0 143.0  68.0
AH:     7.8  HV: 500.0   RAIN:  1102.0              D2C: 10000.0         DEWPT:   7.0             TEMP:  13.0
------------------------------------------------------------------------------------------------

WASHING INTERVAL= B , B            REPAINT INTERVAL= B , B             EXPECTED CORROSION DAMAGE= A , B

LA ANG NEW ORLEANS                    STATE: LA    COUNTY: ORLEANS            LOC: 03002N 09004W
------------------------------------------------------------------------------------------------

WBAN: 93906 GELOC: RQLH EPA STATION: NEW ORLEANS                    TYPE: COMM             LOC: 02957N 09004W
TSP:  119.0 115.0  65.0 SO2:    6.0   6.0   3.0   PCOX:  231.0 214.0   NO2:   48.0  46.0  19.0
AH:    13.8  HV: 450.0   RAIN:  1458.0              D2C:      3.0        DEWPT:  15.0             TEMP:  21.0
------------------------------------------------------------------------------------------------

WASHING INTERVAL= A , B            REPAINT INTERVAL= B , B             EXPECTED CORROSION DAMAGE= AA, A

LANGLEY AFB                           STATE: VA    COUNTY: NA             LOC: 03705N 07621W
------------------------------------------------------------------------------------------------

WBAN: 13702 GELOC: MUHJ EPA STATION: HAMPTON                        TYPE: IND              LOC: 03700N 07624W
TSP:  109.0 103.0  50.0 SO2:  107.0 100.0  35.0   PCOX:  249.0 249.0   NO2:   -1.0  -1.0  -1.0
AH:     9.8  HV: 500.0   RAIN:  1041.0              D2C:       .5        DEWPT:  10.0             TEMP:  16.0
------------------------------------------------------------------------------------------------

WASHING INTERVAL= A , A            REPAINT INTERVAL= B , B             EXPECTED CORROSION DAMAGE= AA, AA

LAREDO AFB                            STATE: TX    COUNTY: WEBB           LOC: 02736N 09931W
------------------------------------------------------------------------------------------------

WBAN: 12907 GELOC: MVJR EPA STATION: LAREDO                         TYPE: COMM             LOC: 02733N 09930W
TSP:  190.0 144.0  79.0 SO2:   -1.0  -1.0  -1.0   PCOX:   -1.0  -1.0   NO2:   -1.0  -1.0  -1.0
AH:    13.5  HV: 600.0   RAIN:   473.0              D2C: 10000.0         DEWPT:  14.0             TEMP:  24.0
------------------------------------------------------------------------------------------------

WASHING INTERVAL= B , B            REPAINT INTERVAL= B , C             EXPECTED CORROSION DAMAGE= A , B

LAUGHLIN AFB                          STATE: TX    COUNTY: VAL VERDE      LOC: 02922N 10047W
------------------------------------------------------------------------------------------------

WBAN: 22001 GELOC: KQBP EPA STATION: DEL RIO                        TYPE: RES              LOC: 02922N 10055W
TSP:   76.0  72.0  64.0 SO2:   -1.0  -1.0  -1.0   PCOX:   -1.0  -1.0   NO2:   -1.0  -1.0  -1.0
AH:    11.2  HV: 600.0   RAIN:   543.0              D2C: 10000.0         DEWPT:  12.0             TEMP:  21.0
------------------------------------------------------------------------------------------------

WASHING INTERVAL= B , B            REPAINT INTERVAL= B , C             EXPECTED CORROSION DAMAGE= A , B
```

LITTLE ROCK AFB STATE: AR COUNTY: PULASKI LOC: 03455N 09209W

WBAN: 03930 GELOC: NKAK EPA STATION: JACKSONVILLE TYPE: COMM LOC: 03452N 09207W
TSP: 109.0 106.0 53.0 SO2: -1.0 -1.0 -1.0 PCOX: -1.0 -1.0 NO2: -1.0 -1.0 -1.0
AH: 10.1 HV: 550.0 RAIN: 1278.0 B2C: 10000.0 DEWPT: 9.0 TEMP: 17.0

WASHING INTERVAL= B , B REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= B , B

LOCKBOURNE- SEE RICKENBACKER STATE: NA COUNTY: NA LOC: NA

WBAN: ***** GELOC: NA EPA STATION: NA TYPE: NA LOC: NA
TSP: -1.0 -1.0 -1.0 SO2: -1.0 -1.0 -1.0 PCOX: -1.0 -1.0 NO2: -1.0 -1.0 -1.0
AH: -.0 HV: -1.0 RAIN: -1.0 B2C: 10000.0 DEWPT: -1.0 TEMP: -1.0

WASHING INTERVAL= C , C REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= C , C

LORING AFB STATE: ME COUNTY: AROOSTOOK LOC: 04657N 06753W

WBAN: 14623 GELOC: NRCH EPA STATION: PRESQUE ISLE TYPE: COMM LOC: 04641N 06759W
TSP: 265.0 239.0 99.0 SO2: 59.0 51.0 9.0 PCOX: -1.0 -1.0 NO2: -1.0 -1.0 -1.0
AH: 4.8 HV: 500.0 RAIN: 1005.0 B2C: 10000.0 DEWPT: 0.0 TEMP: 4.0

WASHING INTERVAL= B , B REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= B , B

LOS ANGELES AFS STATE: CA COUNTY: LOS ANGELES LOC: 03356N 11823W

WBAN: 23145 GELOC: NSAB EPA STATION: LOS ANGELES TYPE: COMM LOC: 03403N 11815W
TSP: 240.0 235.0 109.0 SO2: 51.0 45.0 19.0 PCOX: -1.0 -1.0 NO2: 349.0 279.0 135.0
AH: 10.5 HV: 600.0 RAIN: 318.0 B2C: .5 DEWPT: 11.0 TEMP: 17.0

WASHING INTERVAL= A , A REPAINT INTERVAL= B , C EXPECTED CORROSION DAMAGE= AA, AA

LUKE AFB STATE: AZ COUNTY: MARICOPA LOC: 03333N 11222W

WBAN: 23111 GELOC: NUEX EPA STATION: PHOENIX TYPE: COMM LOC: 03327N 11204W
TSP: 346.0 297.0 162.0 SO2: 27.0 23.0 6.0 PCOX: 265.0 255.0 NO2: 199.0 187.0 82.0
AH: 7.8 HV: 600.0 RAIN: 163.0 B2C: 10000.0 DEWPT: 5.0 TEMP: 22.0

WASHING INTERVAL= B , B REPAINT INTERVAL= A , B EXPECTED CORROSION DAMAGE= A , B

MA ANG BARNES STATE: MA COUNTY: PIONEER VALLEY LOC: 04210N 07243W

WBAN: 14775 GELOC: AXBQ EPA STATION: HOLYOKE TYPE: IND LOC: 04212N 07236W
TSP: 139.0 128.0 58.0 SO2: 117.0 86.0 25.0 PCOX: -1.0 -1.0 NO2: 164.0 132.0 62.0
AH: 6.2 HV: 450.0 RAIN: 1174.0 B2C: 10000.0 DEWPT: 4.0 TEMP: 9.0

WASHING INTERVAL= C , C REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= C , C

```
MACDILL AFB                              STATE: FL    COUNTY: HILLSBOROUGH       LOC: 02751N 08231W
-----------------------------------------------------------------------------------------------------
WBAN: 12810 GELOC: MVZR EPA STATION: TAMPA                      TYPE: MOBILE        LOC: 02750N 08228W
TSP:  72.0  66.0  39.0 SO2:   28.0  21.0   6.0  PCOX:   -1.0  -1.0   NO2:   64.0  38.0  17.0
AH:   15.0  HV: 500.0  RAIN:  1130.0            D2C:     1.0         DEWPT:  17.0        TEMP:  23.0
-----------------------------------------------------------------------------------------------------
WASHING INTERVAL= A , A            REPAINT INTERVAL= C , C          EXPECTED CORROSION DAMAGE= AA, AA

MARCH AFB                                STATE: CA    COUNTY: RIVERSIDE          LOC: 03354N 11715W
-----------------------------------------------------------------------------------------------------
WBAN: 23119 GELOC: PCZP EPA STATION: RIVERSIDE                  TYPE: RES           LOC: 03354N 11723W
TSP:  308.0 233.0 126.0 SO2:   -1.0  -1.0  -1.0 PCOX:  666.0 627.0   NO2:    0.0   0.0  92.0
AH:    8.5  HV: 600.0  RAIN:   224.0            D2C: 10000.0         DEWPT:   6.0        TEMP:  17.0
-----------------------------------------------------------------------------------------------------
WASHING INTERVAL= B , B            REPAINT INTERVAL= A , B          EXPECTED CORROSION DAMAGE= A , B

MATHER AFB                               STATE: CA    COUNTY: SACRAMENTO         LOC: 03834N 12118W
-----------------------------------------------------------------------------------------------------
WBAN: 23206 GELOC: PLXL EPA STATION: SACRAMENTO                 TYPE: COMM          LOC: 03834N 12129W
TSP:  156.0 153.0  77.0 SO2:   -1.0  -1.0  -1.0 PCOX:  255.0 235.0   NO2:    0.0   0.0  50.0
AH:    9.3  HV: 650.0  RAIN:   447.0            D2C: 10000.0         DEWPT:   8.0        TEMP:  17.0
-----------------------------------------------------------------------------------------------------
WASHING INTERVAL= B , B            REPAINT INTERVAL= A , A          EXPECTED CORROSION DAMAGE= A , A

MAXWELL AFB                              STATE: AL    COUNTY: MONTGOMERY         LOC: 03223N 08622W
-----------------------------------------------------------------------------------------------------
WBAN: 13821 GELOC: PNRS EPA STATION: MONTGOMERY                 TYPE: COMM          LOC: 03223N 08619W
TSP:   89.0  80.0  46.0 SO2:   17.0  16.0   6.0  PCOX:   -1.0  -1.0   NO2:   83.0  81.0  55.0
AH:   11.2  HV: 500.0  RAIN:  1255.0            D2C: 10000.0         DEWPT:  13.0        TEMP:  19.0
-----------------------------------------------------------------------------------------------------
WASHING INTERVAL= B , B            REPAINT INTERVAL= C , C          EXPECTED CORROSION DAMAGE= B , B

MCCHORD AFB                              STATE: WA    COUNTY: PIERCE             LOC: 04709N 12229W
-----------------------------------------------------------------------------------------------------
WBAN: 24207 GELOC: PBWY EPA STATION: TACOMA                     TYPE: RES           LOC: 04714N 12226W
TSP:  208.0 188.0  69.0 SO2:   78.0  76.0  17.0  PCOX:   -1.0  -1.0   NO2:   -1.0  -1.0  -1.0
AH:    7.9  HV: 550.0  RAIN:  1043.0            D2C: 10000.0         DEWPT:   6.0        TEMP:  11.0
-----------------------------------------------------------------------------------------------------
WASHING INTERVAL= B , C            REPAINT INTERVAL= C , C          EXPECTED CORROSION DAMAGE= A , C

MCCLELLAN AFB                            STATE: CA    COUNTY: SACRAMENTO         LOC: 03840N 12124W
-----------------------------------------------------------------------------------------------------
WBAN: 23208 GELOC: PRJY EPA STATION: SACRAMENTO                 TYPE: RES           LOC: 03833N 12127W
TSP:  184.0 156.0  62.0 SO2:   13.0  11.0   4.0  PCOX:   -1.0  -1.0   NO2:  188.0 141.0  63.0
AH:    9.2  HV: 650.0  RAIN:   587.0            D2C: 10000.0         DEWPT:   8.0        TEMP:  17.0
-----------------------------------------------------------------------------------------------------
WASHING INTERVAL= B , B            REPAINT INTERVAL= B , B          EXPECTED CORROSION DAMAGE= A , B
```

MCCONNELL AFB STATE: KS COUNTY: SEDGWICK LOC: 03737N 09716W

WBAN: 03923 GELOC: PRQE EPA STATION: WICHITA TYPE: COMM LOC: 03739N 09718W
TSP: 189.0 145.0 62.0 SO2: 20.0 11.0 4.0 PCOX: -1.0 -1.0 NO2: 58.0 57.0 27.0
AH: 7.8 HV: 550.0 RAIN: 805.0 D2C: 10000.0 DEWPT: 6.0 TEMP: 14.0

WASHING INTERVAL= B , C REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= A , C

MCCOY AFB STATE: FL COUNTY: ORANGE LOC: 02827N 08118W

WBAN: 12841 GELOC: PSAX EPA STATION: ORLANDO TYPE: COMM LOC: 02833N 08120W
TSP: 94.0 86.0 51.0 SO2: 29.0 20.0 6.0 PCOX: 0.0 0.0 NO2: 91.0 76.0 32.0
AH: 16.3 HV: 500.0 RAIN: 1161.0 D2C: 10000.0 DEWPT: 16.0 TEMP: 24.0

WASHING INTERVAL= B , B REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= B , B

MCGUIRE AFB STATE: NJ COUNTY: BURLINGTON LOC: 34331N 07436W

WBAN: 14773 GELOC: PTFL EPA STATION: NA TYPE: NA LOC: NA
TSP: -1.0 -1.0 -1.0 SO2: -1.0 -1.0 -1.0 PCOX: -1.0 -1.0 NO2: -1.0 -1.0 -1.0
AH: 7.7 HV: 500.0 RAIN: 1105.0 D2C: 10000.0 DEWPT: 7.0 TEMP: 12.0

WASHING INTERVAL= B , C REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= B , C

MD ANG BALTIMORE STATE: MD COUNTY: BALTIMORE LOC: 03917N 07637W

WBAN: 13777 GELOC: AYCA EPA STATION: BALTIMORE TYPE: COMM LOC: 03917N 07637W
TSP: -1.0 -1.0 -1.0 SO2: 99.0 88.0 19.0 PCOX: 333.0 314.0 NO2: 0.0 0.0 38.0
AH: 7.2 HV: 500.0 RAIN: 1087.0 D2C: 10000.0 DEWPT: 7.0 TEMP: 13.0

WASHING INTERVAL= B , C REPAINT INTERVAL= B , B EXPECTED CORROSION DAMAGE= A , B

ME ANG BANGOR STATE: ME COUNTY: PENOBSCOT LOC: 04448N 06849W

WBAN: 14606 GELOC: FKAW EPA STATION: BANGOR TYPE: COMM LOC: 04448N 06846W
TSP: 202.0 191.0 71.0 SO2: 197.0 167.0 43.0 PCOX: -1.0 -1.0 NO2: 126.0 103.0 51.0
AH: 5.7 HV: 500.0 RAIN: 1120.0 D2C: 10000.0 DEWPT: 2.0 TEMP: 7.0

WASHING INTERVAL= B , C REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= B , C

MI ANG BATTLE CREEK STATE: MI COUNTY: CALHOUN LOC: 04215N 08510W

WBAN: 94829 GELOC: AYZZ EPA STATION: BATTLE CREEK TYPE: COMM LOC: 04219N 08511W
TSP: 187.0 184.0 58.0 SO2: -1.0 -1.0 -1.0 PCOX: -1.0 -1.0 NO2: -1.0 -1.0 -1.0
AH: 6.3 HV: 500.0 RAIN: 848.0 D2C: 10000.0 DEWPT: 4.0 TEMP: 9.0

WASHING INTERVAL= C , C REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= C , C

MI ANG SELFRIDGE STATE: MI COUNTY: MACOMB LOC: 04236N 08250W

WBAN: 14804 GELOC: VGMC EPA STATION: MT CLEMENS TYPE: NA LOC: 04237N 08253W
TSP: 148.0 125.0 55.0 SO2: 30.0 26.0 11.0 PCOX: -1.0 -1.0 NO2: 87.0 63.0 39.0
AH: 6.3 HV: 550.0 RAIN: 717.0 D2C: 10000.0 DEWPT: 4.0 TEMP: 9.0

WASHING INTERVAL= C , C REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= C , C

MINOT AFB STATE: ND COUNTY: WARD LOC: 04825N 10121W

WBAN: 94011 GELOC: QJVF EPA STATION: MINOT TYPE: COMM LOC: 04815N 10118W
TSP: 204.0 144.0 94.0 SO2: -1.0 -1.0 -1.0 PCOX: -1.0 -1.0 NO2: -1.0 -1.0 -1.0
AH: 4.1 HV: 600.0 RAIN: 409.0 D2C: 10000.0 DEWPT: 2.0 TEMP: 4.0

WASHING INTERVAL= B , B REPAINT INTERVAL= B , C EXPECTED CORROSION DAMAGE= B , B

MN ANG MI STP STATE: MN COUNTY: RAMSEY LOC: 04453N 09313W

WBAN: 14922 GELOC: WDEY EPA STATION: ST PAUL TYPE: IND LOC: NA
TSP: 272.0 192.0 85.0 SO2: 120.0 68.0 16.0 PCOX: -1.0 -1.0 NO2: 103.0 100.0 56.0
AH: 5.3 HV: 550.0 RAIN: 727.0 D2C: 10000.0 DEWPT: 1.0 TEMP: 7.0

WASHING INTERVAL= B , C REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= B , C

MO ANG ROSECRANS STATE: MO COUNTY: BUCHANAN LOC: 03946N 09455W

WBAN: 13993 GELOC: ULYB EPA STATION: ST JOSEPH TYPE: COMM LOC: 03945N 09450W
TSP: 233.0 204.0 89.0 SO2: 0.0 0.0 0.0 PCOX: 0.0 0.0 NO2: 0.0 0.0 0.0
AH: 7.2 HV: 550.0 RAIN: 866.0 D2C: 10000.0 DEWPT: 5.0 TEMP: 12.0

WASHING INTERVAL= B , B REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= A , B

MOODY AFB STATE: GA COUNTY: LOWNDES LOC: 03058N 08312W

WBAN: 13857 GELOC: QSEU EPA STATION: VALDOSTA TYPE: RES LOC: 03052N 08317W
TSP: 87.0 78.0 42.0 SO2: 7.0 7.0 3.0 PCOX: -1.0 -1.0 NO2: 54.0 53.0 30.0
AH: 12.3 HV: 500.0 RAIN: 1164.0 D2C: 10000.0 DEWPT: 13.0 TEMP: 20.0

WASHING INTERVAL= B , B REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= B , B

MS ANG JACKSON STATE: MS COUNTY: HINDS LOC: 03220N 09013W

WBAN: 13956 GELOC: LRXY EPA STATION: JACKSON TYPE: COMM LOC: 03218N 09011W
TSP: 150.0 128.0 59.0 SO2: 41.0 39.0 17.0 PCOX: -1.0 -1.0 NO2: -1.0 -1.0 -1.0
AH: 11.5 HV: 500.0 RAIN: 1287.0 D2C: 10000.0 DEWPT: 12.0 TEMP: 19.0

WASHING INTERVAL= B , B REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= B , B

MS ANG KEY FLD STATE: MS COUNTY: LAUDERDALE LOC: 03220N 08845W

WBAN: 13817 GELOC: MAVL EPA STATION: MERIDIAN TYPE: RES LOC: 03222N 08842W
TSP: 92.0 85.0 46.0 SO2: 26.0 17.0 4.0 PCOX: -1.0 -1.0 NO2: -1.0 -1.0 -1.0
AH: 11.2 HV: 500.0 RAIN: 1359.0 D2C: 10000.0 DEWPT: 12.0 TEMP: 18.0

WASHING INTERVAL= B , B REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= B , B

MT ANG GT FALLS STATE: MT COUNTY: CASCADE LOC: 04729N 11122W

WBAN: 24143 GELOC: JKSE EPA STATION: GT FALLS TYPE: IND LOC: 04729N 11117W
TSP: 124.0 124.0 45.0 SO2: -1.0 -1.0 -1.0 PCOX: -1.0 -1.0 NO2: -1.0 -1.0 -1.0
AH: 4.5 HV: 600.0 RAIN: 369.0 D2C: 10000.0 DEWPT: 3.0 TEMP: 8.0

WASHING INTERVAL= C , C REPAINT INTERVAL= B , C EXPECTED CORROSION DAMAGE= C , C

MT HOME AFB STATE: ID COUNTY: ELMORE LOC: 04303N 11552W

WBAN: 24106 GELOC: QYZH EPA STATION: MT HOME TYPE: COMM LOC: 04306N 11541W
TSP: 272.0 170.0 84.0 SO2: 8.0 6.0 3.0 PCOX: -1.0 -1.0 NO2: -1.0 -1.0 -1.0
AH: 2.8 HV: -1.0 RAIN: 100.0 D2C: 10000.0 DEWPT: 1.0 TEMP: 1.0

WASHING INTERVAL= B , C REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= B , C

MYRTLE BEACH AFB STATE: SC COUNTY: HORRY LOC: 03341N 07856W

WBAN: 13717 GELOC: RBRD EPA STATION: CONWAY TYPE: COMM LOC: 03350N 07902W
TSP: 99.0 78.0 43.0 SO2: 28.0 23.0 4.0 PCOX: -1.0 -1.0 NO2: 64.0 48.0 20.0
AH: 11.4 HV: 500.0 RAIN: 1308.0 D2C: .5 DEWPT: 13.0 TEMP: 17.0

WASHING INTERVAL= A , A REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= AA, AA

NC ANG DOUGLAS STATE: NC COUNTY: MECKLENBURG LOC: 03513N 08056W

WBAN: 13881 GELOC: FJRP EPA STATION: CHARLOTTE TYPE: IND LOC: 03506N 08054W
TSP: 81.0 79.0 43.0 SO2: 46.0 36.0 11.0 PCOX: -1.0 -1.0 NO2: 77.0 68.0 39.0
AH: 9.3 HV: 500.0 RAIN: 1087.0 D2C: 10000.0 DEWPT: 9.0 TEMP: 16.0

WASHING INTERVAL= B , B REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= B , B

ND ANG ST UNIV STATE: ND COUNTY: CASS LOC: 04654N 09648W

WBAN: 14914 GELOC: GMWM EPA STATION: FARGO TYPE: COMM LOC: 04653N 09647W
TSP: 125.0 123.0 67.0 SO2: 2.0 2.0 5.0 PCOX: -1.0 -1.0 NO2: 56.0 56.0 53.0
AH: 4.8 HV: 550.0 RAIN: 543.0 D2C: 10000.0 DEWPT: 1.0 TEMP: 5.0

WASHING INTERVAL= B , C REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= B , C

NE ANG LINCOLN STATE: NE COUNTY: LANCASTER LOC: 04051N 09646W

WBAN: 14904 GELOC: MGCB EPA STATION: LINCOLN TYPE: COMM LOC: 04058N 09642W
TSP: 190.0 160.0 78.0 SO2: 47.0 26.0 6.0 PCOX: -1.0 -1.0 NO2: 112.0 91.0 46.0
AH: 6.8 HV: 550.0 RAIN: 747.0 D2C: 10000.0 DEWPT: 4.0 TEMP: 11.0

WASHING INTERVAL= B , C REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= B , C

NELLIS AFB STATE: NV COUNTY: CLARK LOC: 03615N 11502W

WBAN: 23112 GELOC: RKMF EPA STATION: LAS VEGAS TYPE: COMM LOC: 03609N 11509W
TSP: 334.0 306.0 134.0 SO2: 49.0 42.0 10.0 PCOX: -1.0 -1.0 NO2: 0.0 0.0 34.0
AH: 5.0 HV: 650.0 RAIN: 92.0 D2C: 10000.0 DEWPT: 1.0 TEMP: 19.0

WASHING INTERVAL= B , B REPAINT INTERVAL= B , B EXPECTED CORROSION DAMAGE= B , B

NJ ANG ATLANTIC CITY STATE: NJ COUNTY: NA LOC: 03927N 07435W

WBAN: 13753 GELOC: AQRC EPA STATION: NA TYPE: NA LOC: NA
TSP: -1.0 -1.0 -1.0 SO2: -1.0 -1.0 -1.0 PCOX: -1.0 -1.0 NO2: -1.0 -1.0 -1.0
AH: 8.0 HV: 500.0 RAIN: 1037.0 D2C: 10000.0 DEWPT: 6.0 TEMP: 12.0

WASHING INTERVAL= B , C REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= B , C

NORTON AFB STATE: CA COUNTY: SAN BERNARDINO LOC: 03406N 11714W

WBAN: 23122 GELOC: SCEY EPA STATION: SAN BERNARDINO TYPE: COMM LOC: 03404N 11717W
TSP: 242.0 232.0 113.0 SO2: 91.0 79.0 23.0 PCOX: 627.0 588.0 NO2: 156.0 154.0 85.0
AH: 9.1 HV: 650.0 RAIN: 293.0 D2C: 10000.0 DEWPT: 7.0 TEMP: 18.0

WASHING INTERVAL= B , B REPAINT INTERVAL= A , A EXPECTED CORROSION DAMAGE= A , A

NV ANG RENO STATE: NV COUNTY: WASHOE LOC: 03930N 11947W

WBAN: 23185 GELOC: UCTL EPA STATION: RENO TYPE: COMM LOC: 03931N 11948W
TSP: -1.0 -1.0 -1.0 SO2: 28.0 13.0 4.0 PCOX: 186.0 173.0 NO2: 0.0 0.0 139.0
AH: 5.3 HV: 650.0 RAIN: 180.0 D2C: 10000.0 DEWPT: 2.0 TEMP: 11.0

WASHING INTERVAL= C , C REPAINT INTERVAL= A , A EXPECTED CORROSION DAMAGE= B , B

NY ANG HANCOCK STATE: NY COUNTY: ONONDAGA LOC: 04307N 07607W

WBAN: 14720 GELOC: KGHT EPA STATION: SYRACUSE TYPE: MOBILE LOC: 04303N 07609W
TSP: 199.0 142.0 70.0 SO2: 102.0 100.0 44.0 PCOX: 78.0 69.0 NO2: 0.0 0.0 49.0
AH: 6.5 HV: 500.0 RAIN: 958.0 D2C: 10000.0 DEWPT: 3.0 TEMP: 9.0

WASHING INTERVAL= A , C REPAINT INTERVAL= B , B EXPECTED CORROSION DAMAGE= B , B

NY ANG NIAGRA FALLS STATE: NY COUNTY: NIAGRA LOC: 04306N 07857W

WBAN: 04728 GELOC: RVJV EPA STATION: NIAGRA FALLS TYPE: COMM LOC: 04304N 07903W
TSP: 140.0 133.0 64.0 SO2: 175.0 149.0 30.0 PCOX: -1.0 -1.0 NO2: -1.0 -1.0 -1.0
AH: 6.6 HV: 500.0 RAIN: 867.0 D2C: 10000.0 DEWPT: 4.0 TEMP: 9.0

WASHING INTERVAL= B , C REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= B , C

NY ANG SCHENECTADY STATE: NY COUNTY: SCHENECTADY LOC: 04251N 07356W

WBAN: 04782 GELOC: VBDZ EPA STATION: SCHENECTADY TYPE: RES LOC: 04248N 07356W
TSP: -1.0 -1.0 -1.0 SO2: 139.0 134.0 38.0 PCOX: 98.0 92.0 NO2: 0.0 0.0 31.0
AH: 6.3 HV: 450.0 RAIN: 901.0 D2C: 10000.0 DEWPT: 3.0 TEMP: 9.0

WASHING INTERVAL= C , C REPAINT INTERVAL= B , B EXPECTED CORROSION DAMAGE= B , B

NY ANG SUFFOLK STATE: NY COUNTY: SUFFOLK LOC: 04052N 07253W

WBAN: 94703 GELOC: WKVJ EPA STATION: SUFFOLK TYPE: COMM LOC: 04102N 07157W
TSP: 93.0 79.0 37.0 SO2: 18.0 18.0 6.0 PCOX: -1.0 -1.0 NO2: -1.0 -1.0 -1.0
AH: 7.6 HV: 500.0 RAIN: 874.0 D2C: 10000.0 DEWPT: 3.0 TEMP: 11.0

WASHING INTERVAL= B , C REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= B , C

NY ANG WESTCHESTER STATE: NY COUNTY: WESTCHESTER LOC: 04104N 07343W

WBAN: 94745 GELOC: YSSF EPA STATION: WT PLAINS TYPE: COMM LOC. 04102N 07346W
TSP: 115.0 110.0 53.0 SO2: 125.0 99.0 29.0 PCOX: -1.0 -1.0 NO2: -1.0 -1.0 -1.0
AH: 7.2 HV: 450.0 RAIN: 1300.0 D2C: 10000.0 DEWPT: 6.0 TEMP: 11.0

WASHING INTERVAL= B , C REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= B , C

OFFUTT AFB STATE: NB COUNTY: DOUGLAS LOC: 04107N 09554W

WBAN: 14949 GELOC: SGBP EPA STATION: OMAHA TYPE: COMM LOC: 04112N 09556W
TSP: 211.0 145.0 98.0 SO2: 33.0 33.0 8.0 PCOX: -1.0 -1.0 NO2: 72.0 71.0 33.0
AH: 6.9 HV: 550.0 RAIN: 740.0 D2C: 10000.0 DEWPT: 4.0 TEMP: 11.0

WASHING INTERVAL= B , B REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= B , B

OH ANG MANSFIELD STATE: OH COUNTY: RICHLAND LOC: 04049N 08231W

WBAN: 14891 GELOC: PBXP EPA STATION: MANSFIELD TYPE: IND LOC: 04047N 08231W
TSP: 193.0 189.0 69.0 SO2: 103.0 45.0 13.0 PCOX: -1.0 -1.0 NO2: 204.0 84.0 38.0
AH: 6.7 HV: 500.0 RAIN: 854.0 D2C: 10000.0 DEWPT: 5.0 TEMP: 9.0

WASHING INTERVAL= B , C REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= B , C

OH ANG TOLEDO STATE: OH COUNTY: LUCAS LOC: 04139N 08332W

WBAN: 14809 GELOC: WYTB EPA STATION: TOLEDO TYPE: COMM LOC: 04139N 08332W
TSP: 136.0 110.0 64.0 SO2: 144.0 75.0 32.0 PCOX: -1.0 -1.0 NO2: 106.0 105.0 57.0
AH: 6.4 HV: 550.0 RAIN: 732.0 D2C: 10000.0 DEWPT: 4.0 TEMP: 9.0

WASHING INTERVAL= B , C REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= B , C

OK ANG TULSA STATE: OK COUNTY: TULSA LOC: 03612N 09554W

WBAN: 13968 GELOC: XHZG EPA STATION: TULSA TYPE: RURAL LOC: 03607N 09551W
TSP: 192.0 123.0 61.0 SO2: 30.0 14.0 4.0 PCOX: -1.0 -1.0 NO2: 763.0 418.0 132.0
AH: 8.9 HV: 550.0 RAIN: 930.0 D2C: 10000.0 DEWPT: 8.0 TEMP: 16.0

WASHING INTERVAL= B , C REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= B , C

OR ANG PORTLAND STATE: OR COUNTY: MULTNOMAH LOC: 04532N 12240W

WBAN: 24274 GELOC: TQFJ EPA STATION: PORTLAND TYPE: COMM LOC: 04531N 12240W
TSP: 125.0 105.0 57.0 SO2: 119.0 86.0 19.0 PCOX: -1.0 -1.0 NO2: 102.0 98.0 57.0
AH: 8.0 HV: 550.0 RAIN: 1723.0 D2C: 10000.0 DEWPT: 7.0 TEMP: 12.0

WASHING INTERVAL= B , B REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= B , B

OTIS AFB STATE: MA COUNTY: SE MASS LOC: 04139N 07031W

WBAN: 14704 GELOC: SPBW EPA STATION: FALMOUTH TYPE: RES LOC: 04133N 07036W
TSP: 100.0 71.0 35.0 SO2: 28.0 28.0 7.0 PCOX: -1.0 -1.0 NO2: 49.0 41.0 19.0
AH: 7.7 HV: 500.0 RAIN: 1243.0 D2C: 10000.0 DEWPT: 6.0 TEMP: 11.0

WASHING INTERVAL= B , C REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= B , C

PA ANG MIDDLETOWN STATE: PA COUNTY: DAUPHIN LOC: 04012N 07645W

WBAN: 14711 GELOC: GERS EPA STATION: MIDDLETOWN TYPE: COMM LOC: 04012N 07644W
TSP: 183.0 157.0 66.0 SO2: -1.0 -1.0 -1.0 PCOX: -1.0 -1.0 NO2: -1.0 -1.0 -1.0
AH: 7.5 HV: 500.0 RAIN: 1016.0 D2C: 10000.0 DEWPT: 6.0 TEMP: 12.0

WASHING INTERVAL= B , C REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= A , C

PA ANG PITTSBURGH STATE: PA COUNTY: ALLEGHENY LOC: 04030N 08013W

WBAN: 94823 GELOC: THGC EPA STATION: PITTSBURGH TYPE: COMM LOC: 04026N 08000W
TSP: 226.0 165.0 95.0 SO2: 168.0 139.0 54.0 PCOX: -1.0 -1.0 NO2: 205.0 128.0 83.0
AH: 6.9 HV: 450.0 RAIN: 890.0 D2C: 10000.0 DEWPT: 4.0 TEMP: 11.0

WASHING INTERVAL= A , B REPAINT INTERVAL= B , C EXPECTED CORROSION DAMAGE= B , B

```
PA ANG WILLOW GROVE                    STATE: PA    COUNTY: PHILADELPHIA        LOC: 04012N 07508W
--------------------------------------------------------------------------------------------------
WBAN: 14793 GELOC: ZAVW EPA STATION: PHILADELPHIA                   TYPE: RES            LOC: 04000N 07505W
TSP:  186.0 185.0  81.0 SO2:  291.0 291.0  63.0   PCOX:  333.0 333.0  NO2:    0.0   0.0  81.0
AH:     6.9  HV: 500.0   RAIN:  1310.0            D2C: 10000.0        DEWPT:   6.0            TEMP:  12.0
--------------------------------------------------------------------------------------------------
WASHING INTERVAL= A , C            REPAINT INTERVAL= B , B            EXPECTED CORROSION DAMAGE= A , B

PATRICK AFB                            STATE: FL    COUNTY: BREVARD             LOC: 02814N 08036W
--------------------------------------------------------------------------------------------------
WBAN: 12867 GELOC: SXHT EPA STATION: MERRITT IS                     TYPE: COMM           LOC: 02837N 08042W
TSP:   88.0  82.0  35.0 SO2:   -1.0  -1.0  -1.0   PCOX:   -1.0  -1.0  NO2:   -1.0  -1.0  -1.0
AH:    16.1  HV: 500.0   RAIN:  1184.0            D2C:      .5        DEWPT:  18.0            TEMP:  23.0
--------------------------------------------------------------------------------------------------
WASHING INTERVAL= A , A            REPAINT INTERVAL= C , C            EXPECTED CORROSION DAMAGE= AA, AA

PEASE AFB                              STATE: NH    COUNTY: ROCKINGHAM          LOC: 04305N 07049W
--------------------------------------------------------------------------------------------------
WBAN: 04743 GELOC: SZDT EPA STATION: PORTSMOUTH                     TYPE: RES            LOC: 04305N 07047W
TSP:   76.0  74.0  35.0 SO2:   72.0  70.0  22.0   PCOX:   -1.0  -1.0  NO2:  100.0  90.0  39.0
AH:     6.1  HV: 500.0   RAIN:  1123.0            D2C:     1.0        DEWPT:   3.0            TEMP:   9.0
--------------------------------------------------------------------------------------------------
WASHING INTERVAL= A , A            REPAINT INTERVAL= C , C            EXPECTED CORROSION DAMAGE= AA, AA

PETERSON AFB                           STATE: CO    COUNTY: EL PASO             LOC: 03849N 10442W
--------------------------------------------------------------------------------------------------
WBAN: 23029 GELOC: TDKA EPA STATION: COLORADO SPRINGS               TYPE: COMM           LOC. 03849N 10530W
TSP:  254.0 236.0  92.0 SO2:   -1.0  -1.0  -1.0   PCOX:   -1.0  -1.0  NO2:   -1.0  -1.0  -1.0
AH:     4.8  HV: 600.0   RAIN:   369.0            D2C: 10000.0        DEWPT:   1.0            TEMP:   9.0
--------------------------------------------------------------------------------------------------
WASHING INTERVAL= B , B            REPAINT INTERVAL= B , C            EXPECTED CORROSION DAMAGE= B , B

PLATTSBURGH AFB                        STATE: NY    COUNTY: CLINTON             LOC: 04441N 07331W
--------------------------------------------------------------------------------------------------
WBAN: 94733 GELOC: THWA EPA STATION: PLATTSBURGH                    TYPE: RES            LOC: 04442N 07328W
TSP:   57.0  50.0  30.0 SO2:   -1.0  -1.0  -1.0   PCOX:   -1.0  -1.0  NO2:   -1.0  -1.0  -1.0
AH:     5.4  HV: 450.0   RAIN:   773.0            D2C: 10000.0        DEWPT:   2.0            TEMP:   7.0
--------------------------------------------------------------------------------------------------
WASHING INTERVAL= C , C            REPAINT INTERVAL= C , C            EXPECTED CORROSION DAMAGE= C , C

POPE AFB                               STATE: NC    COUNTY: CUMBERLAND          LOC: 03500N 07853W
--------------------------------------------------------------------------------------------------
WBAN: 93740 GELOC: THHK EPA STATION: FAYETTEVILLE                   TYPE: RES            LOC: 03505N 07850W
TSP:  283.0 158.0  81.0 SO2:   82.0  63.0  11.0   PCOX:   -1.0  -1.0  NO2:   81.0  72.0  42.0
AH:    10.5  HV: 550.0   RAIN:  1210.0            D2C: 10000.0        DEWPT:  11.0            TEMP:  17.0
--------------------------------------------------------------------------------------------------
WASHING INTERVAL= B , B            REPAINT INTERVAL= C , C            EXPECTED CORROSION DAMAGE= A , B
```

```
RANDOLPH AFB                          STATE: TX    COUNTY: BEXAR            LOC: 02932N 09817W
----------------------------------------------------------------------------------------------
WBAN: 12911 GELOC: TYMX EPA STATION: SAN ANTONIO                      TYPE: RES          LOC: 02930N 09832W
TSP:  283.0 120.0  59.0 SO2:    3.0   3.0   3.0   PCOX:  370.0 347.0  NO2:   77.0  61.0  23.0
AH:    12.1  HV: 600.0  RAIN:  676.0              D2C: 10000.0        DEWPT:  13.0        TEMP:  21.0
----------------------------------------------------------------------------------------------
WASHING INTERVAL= B , B            REPAINT INTERVAL= A , B           EXPECTED CORROSION DAMAGE= A , A


REESE AFB                             STATE: TX    COUNTY: LUBBOCK          LOC: 03336N 10203W
----------------------------------------------------------------------------------------------
WBAN: 23021 GELOC: UBNY EPA STATION: LUBBOCK                          TYPE: COMM         LOC: 03335N 10151W
TSP:  199.0 190.0  81.0 SO2:    2.0   2.0   3.0   PCOX:   -1.0  -1.0  NO2:   47.0  40.0  18.0
AH:     7.2  HV: 600.0  RAIN:  406.0              D2C: 10000.0        DEWPT:   4.0        TEMP:  16.0
----------------------------------------------------------------------------------------------
WASHING INTERVAL= B , C            REPAINT INTERVAL= B , C           EXPECTED CORROSION DAMAGE= A , C


RI ANG THEO GREEN                     STATE: RI    COUNTY: KENT             LOC: 04144N 07126W
----------------------------------------------------------------------------------------------
WBAN: 14765 GELOC: WVAB EPA STATION: WARWICK                          TYPE: COMM         LOC: 04144N 07126W
TSP:   80.0  56.0  50.0 SO2:    2.0   2.0   3.0   PCOX:   -1.0  -1.0  NO2:   22.0  17.0  12.0
AH:     6.6  HV: 500.0  RAIN: 1085.0              D2C:       3.5      DEWPT:   4.0        TEMP:  10.0
----------------------------------------------------------------------------------------------
WASHING INTERVAL= A , C            REPAINT INTERVAL= C , C           EXPECTED CORROSION DAMAGE= AA, C


RICHARDS GEBAUR AFB                   STATE: MO    COUNTY: JACKSON          LOC: 03851N 09433W
----------------------------------------------------------------------------------------------
WBAN: 03929 GELOC: UEBL EPA STATION: GRANDVIEW                        TYPE: COMM         LOC: 03853N 09432W
TSP:   85.0  83.0  62.0 SO2:   -1.0  -1.0  -1.0   PCOX:   -1.0  -1.0  NO2:   -1.0  -1.0  -1.0
AH:     7.7  HV: 550.0  RAIN:  884.0              D2C: 10000.0        DEWPT:   6.0        TEMP:  13.0
----------------------------------------------------------------------------------------------
WASHING INTERVAL= B , C            REPAINT INTERVAL= C , C           EXPECTED CORROSION DAMAGE= A , C


RICKENBACKER AFB                      STATE: OH    COUNTY: FRANKLIN         LOC: 03949N 08255W
----------------------------------------------------------------------------------------------
WBAN: 13812 GELOC: MLZT EPA STATION: COLUMBUS                         TYPE: COMM         LOC: 03955N 08253W
TSP:  146.0 108.0  53.0 SO2:    0.0   0.0   0.0   PCOX:    0.0   0.0  NO2:    0.0   0.0   0.0
AH:     7.7  HV: 500.0  RAIN:  871.0              D2C: 10000.0        DEWPT:   6.0        TEMP:  12.0
----------------------------------------------------------------------------------------------
WASHING INTERVAL= B , C            REPAINT INTERVAL= C , C           EXPECTED CORROSION DAMAGE= B , C


ROBINS AFB                            STATE: GA    COUNTY: BIBB             LOC: 03250N 08338W
----------------------------------------------------------------------------------------------
WBAN: 93853 GELOC: UHHZ EPA STATION: MACON                            TYPE: RES          LOC: 03248N 08338W
TSP:  164.0 147.0  65.0 SO2:   25.0  21.0   5.0   PCOX:   -1.0  -1.0  NO2:  109.0  85.0  40.0
AH:    11.3  HV: 500.0  RAIN: 1005.0              D2C: 10000.0        DEWPT:  12.0        TEMP:  19.0
----------------------------------------------------------------------------------------------
WASHING INTERVAL= B , B            REPAINT INTERVAL= C , C           EXPECTED CORROSION DAMAGE= A , B
```

SC ANG MCENTIRE   STATE: SC   COUNTY: RICHLAND   LOC: 03358N 08048W

WBAN: 03858 GELOC: PSTE EPA STATION: COLUMBIA   TYPE: COMM   LOC: 03400N 08103W

TSP: 92.0 87.0 48.0 SO2: 75.0 6.0 4.0 PCOX: -1.0 -1.0   NO2: 73.0 73.0 37.0

AH: 10.5 HV: 500.0 RAIN: 1092.0   D2C: 10000.0   DEWPT: 11.0   TEMP: 18.0

WASHING INTERVAL= B , B   REPAINT INTERVAL= C , C   EXPECTED CORROSION DAMAGE= B , B

SCOTT AFB   STATE: IL   COUNTY: ST CLAIR   LOC: 03833N 08951W

WBAN: 13802 GELOC: VDTD EPA STATION: E ST LOUIS   TYPE: IND   LOC: 03837N 09009W

TSP: -1.0 -1.0 -1.0 SO2: 261.0 239.0 61.0 PCOX: 302.0 282.0   NO2: 100.0 83.0 53.0

AH: 7.8 HV: 550.0 RAIN: 1008.0   D2C: 10000.0   DEWPT: 7.0   TEMP: 13.0

WASHING INTERVAL= B , C   REPAINT INTERVAL= B , B   EXPECTED CORROSION DAMAGE= A , B

SD ANG JOE FOSS   STATE: SD   COUNTY: MINNEHAHA   LOC: 04334N 09644W

WBAN: 14944 GELOC: LUXC EPA STATION: SIOUX FALLS   TYPE: COMM   LOC: 04335N 09644W

TSP: 202.0 122.0 60.0 SO2: 49.0 42.0 6.0 PCOX: -1.0 -1.0   NO2: -1.0 -1.0 -1.0

AH: 5.4 HV: 550.0 RAIN: 622.0   D2C: 10000.0   DEWPT: 1.0   TEMP: 8.0

WASHING INTERVAL= C , C   REPAINT INTERVAL= C , C   EXPECTED CORROSION DAMAGE= C , C

SEYMOR JOHNSON AFB   STATE: NC   COUNTY: WAYNE   LOC: 03520N 07758W

WBAN: 13713 GELOC: VKAG EPA STATION: GOLDSBORO   TYPE: COMM   LOC: 03523N 07759W

TSP: 170.0 135.0 74.0 SO2: 36.0 11.0 6.0 PCOX: -1.0 -1.0   NO2: 69.0 67.0 22.0

AH: 9.7 HV: 500.0 RAIN: 1325.0   D2C: 10000.0   DEWPT: 10.0   TEMP: 16.0

WASHING INTERVAL= B , B   REPAINT INTERVAL= C , C   EXPECTED CORROSION DAMAGE= A , B

SHAW AFB   STATE: SC   COUNTY: SUMTER   LOC: 03358N 08028W

WBAN: 13849 GELOC: VLSB EPA STATION: SUMTER   TYPE: COMM   LOC: 03355N 08020W

TSP: 327.0 203.0 70.0 SO2: 74.0 43.0 4.0 PCOX: -1.0 -1.0   NO2: 76.0 62.0 33.0

AH: 10.5 HV: 500.0 RAIN: 1092.0   D2C: 10000.0   DEWPT: 11.0   TEMP: 18.0

WASHING INTERVAL= B , B   REPAINT INTERVAL= C , C   EXPECTED CORROSION DAMAGE= A , B

TINKER AFB   STATE: OK   COUNTY: OKLAHOMA   LOC: 03525N 09723W

WBAN: 13919 GELOC: WWYK EPA STATION: OKLAHOMA CITY   TYPE: COMM   LOC: 03524N 09729W

TSP: 135.0 [illegible] 58.0 SO2: 5.0 5.0 5.0 PCOX: -1.0 -1.0   NO2: 67.0 64.0 31.0

AH: 8.[illegible] HV: 550.0 RAIN: 851.0   D2C: 10000.0   DEWPT: 8.0   TEMP: 16.0

WASHING INTERVAL= B , C   REPAINT INTERVAL= C , C   EXPECTED CORROSION DAMAGE= B , C

```
TN ANG MCGHEE TYSON                STATE: TN    COUNTY: KNOX           LOC: 03549N 08400W
-----------------------------------------------------------------------------------------------
WBAN: 03851 GELOC: PSXE EPA STATION: KNOXVILLE                   TYPE: IND          LOC: 03546N 08338W
TSP:  163.0 138.0  78.0 SO2:   44.0  35.0   8.0  PCOX:   -1.0  -1.0   NO2:  83.0  75.0  44.0
AH:   10.2  HV: 500.0  RAIN:  1300.0             D2C: 10000.0         DEWPT:  13.0       TEMP:  17.0
-----------------------------------------------------------------------------------------------

WASHING INTERVAL= B , B          REPAINT INTERVAL= C , C          EXPECTED CORROSION DAMAGE= A , B


TN ANG MEMPHIS                     STATE: TN    COUNTY: SHELBY         LOC: 03504N 08959W
-----------------------------------------------------------------------------------------------
WBAN: 13862 GELOC: PYJX EPA STATION: MEMPHIS                     TYPE: RES          LOC: 03508N 08959W
TSP:  113.0  73.0  77.0 SO2:   50.0  33.0  30.0  PCOX:   -1.0  -1.0   NO2: 123.0 171.0  68.0
AH:   10.1  HV: 500.0  RAIN:  1300.0             D2C: 10000.0         DEWPT:  10.0       TEMP:  17.0
-----------------------------------------------------------------------------------------------

WASHING INTERVAL= B , B          REPAINT INTERVAL= C , C          EXPECTED CORROSION DAMAGE= A , B


TN ANG NASHVILLE                   STATE: TN    COUNTY: DAVIDSON       LOC: 03610N 08647W
-----------------------------------------------------------------------------------------------
WBAN: 93858 GELOC: RHDQ EPA STATION: NASHVILLE                   TYPE: IND          LOC: 03611N 08648W
TSP:  211.0 161.0  87.0 SO2:   49.0  44.0  16.0  PCOX:   -1.0  -1.0   NO2: 115.0 107.0  65.0
AH:    9.7  HV: 500.0  RAIN:  1156.0             D2C: 10000.0         DEWPT:   9.0       TEMP:  16.0
-----------------------------------------------------------------------------------------------

WASHING INTERVAL= B , B          REPAINT INTERVAL= C , C          EXPECTED CORROSION DAMAGE= A , A


TRAVIS AFB                         STATE: CA    COUNTY: SOLANO         LOC: 03816N 12156W
-----------------------------------------------------------------------------------------------
WBAN: 23202 GELOC: XDAT EPA STATION: VALLEJO                     TYPE: COMM         LOC: 03806N 122.4W
TSP:  176.0 136.0  69.0 SO2:   35.0  31.0   5.0  PCOX:  372.0 274.0   NO2:   0.0   0.0  59.0
AH:    9.0  HV: 650.0  RAIN:   424.0             D2C:      4.0        DEWPT:   8.0       TEMP:  16.0
-----------------------------------------------------------------------------------------------

WASHING INTERVAL= A , B          REPAINT INTERVAL= A , A          EXPECTED CORROSION DAMAGE= AA, A


TX ANG HOUSTON                     STATE: TX    COUNTY: HARRIS         LOC: 02946N 09522W
-----------------------------------------------------------------------------------------------
WBAN: 12945 GELOC: CCNN EPA STATION: HOUSTON                     TYPE: RES          LOC: 02946N 09513W
TSP:  198.0 162.0  95.0 SO2:   56.0  38.0   5.0  PCOX:  582.0 523.0   NO2: 106.0 101.0  37.0
AH:   13.6  HV: 550.0  RAIN:  1161.0             D2C: 10000.0         DEWPT:  15.0       TEMP:  21.0
-----------------------------------------------------------------------------------------------

WASHING INTERVAL= B , B          REPAINT INTERVAL= B , B          EXPECTED CORROSION DAMAGE= A , A


TYNDALL AFB                        STATE: FL    COUNTY: BAY            LOC: 03004N 08585W
-----------------------------------------------------------------------------------------------
WBAN: 13846 GELOC: XLMU EPA STATION: PANAMA CITY                 TYPE: RES          LOC: 03012N 08541W
TSP:  137.0 129.0  53.0 SO2:  128.0  20.0   7.0  PCOX:   -1.0  -1.0   NO2:  81.0  28.0  11.0
AH:   13.8  HV: 500.0  RAIN:  1359.0             D2C:      2.0        DEWPT:  16.0       TEMP:  21.0
-----------------------------------------------------------------------------------------------

WASHING INTERVAL= A , A          REPAINT INTERVAL= C , C          EXPECTED CORROSION DAMAGE= AA, AA
```

```
VA ANG BYRD FLD                    STATE: VA    COUNTY: ROANOKE           LOC: 03730N 07720W
-----------------------------------------------------------------------------------------------
WBAN: 13703 GELOC: CVVM EPA STATION: RICHMOND                   TYPE: IND            LOC: 03731N 07726W
TSP:  198.0 128.0  90.0 SO2:   65.0  57.0  27.0   PCOX:   -1.0  -1.0   NO2:  105.0  92.0  61.0
AH:     8.2  HV: 500.0  RAIN:  1052.0             B2C: 10000.0         DEWPT:   8.0          TEMP:  14.0
-----------------------------------------------------------------------------------------------
WASHING INTERVAL= B , B           REPAINT INTERVAL= C , C          EXPECTED CORROSION DAMAGE= A , B

VANCE AFB                          STATE: OK    COUNTY: GARFIELD          LOC: 03621N 09755W
-----------------------------------------------------------------------------------------------
WBAN: 13909 GELOC: XTLF EPA STATION: ENID                       TYPE: COMM           LOC: 03623N 09754W
TSP:  140.0 137.0  73.0 SO2:   -1.0  -1.0  -1.0   PCOX:   -1.0  -1.0   NO2:   -1.0  -1.0  -1.0
AH:     8.7  HV: 600.0  RAIN:   714.0             B2C: 10000.0         DEWPT:   7.0          TEMP:  16.0
-----------------------------------------------------------------------------------------------
WASHING INTERVAL= B , C           REPAINT INTERVAL= B , C          EXPECTED CORROSION DAMAGE= A , C

VANDENBERG AFB                     STATE: CA    COUNTY: SANTA BARBARA     LOC: 03443N 12034W
-----------------------------------------------------------------------------------------------
WBAN: 93223 GELOC: XUMU EPA STATION: SANTA MARIA                TYPE: COMM           LOC: 03450N 12030W
TSP:  161.0 133.0  89.0 SO2:   -1.0  -1.0  -1.0   PCOX:   -1.0  -1.0   NO2:   -1.0  -1.0  -1.0
AH:     8.9  HV: 650.0  RAIN:   315.0             D2C:      2.5        DEWPT:   8.0          TEMP:  13.0
-----------------------------------------------------------------------------------------------
WASHING INTERVAL= A , B           REPAINT INTERVAL= B , B          EXPECTED CORROSION DAMAGE= AA, B

VT ANG BURLINGTON                  STATE: VT    COUNTY: CHITTENDEN        LOC: 04428N 07309W
-----------------------------------------------------------------------------------------------
WBAN: 14742 GELOC: CURZ EPA STATION: BURLINGTON                 TYPE: COMM           LOC: 04429N 07312W
TSP:  117.0 105.0  64.0 SO2:  107.0  94.0  24.0   PCOX:  196.0 196.0   NO2:   -1.0  -1.0  -1.0
AH:     5.9  HV: 450.0  RAIN:   859.0             D2C: 10000.0         DEWPT:   2.0          TEMP:   8.0
-----------------------------------------------------------------------------------------------
WASHING INTERVAL= B , C           REPAINT INTERVAL= B , B          EXPECTED CORROSION DAMAGE= B , B

WA ANG SPOKANE                     STATE: WA    COUNTY: SPOKANE           LOC: 04738N 11732W
-----------------------------------------------------------------------------------------------
WBAN: 24157 GELOC: VZBT EPA STATION: SPOKANE                    TYPE: MOBILE         LOC: 04739N 11739W
TSP:  163.0 162.0  92.0 SO2:   -1.0  -1.0  -1.0   PCOX:   -1.0  -1.0   NO2:   -1.0  -1.0  -1.0
AH:     5.7  HV: 650.0  RAIN:   460.0             B2C: 10000.0         DEWPT:   1.0          TEMP:   9.0
-----------------------------------------------------------------------------------------------
WASHING INTERVAL= B , B           REPAINT INTERVAL= B , B          EXPECTED CORROSION DAMAGE= B , B

WEBB AFB                           STATE: TX    COUNTY: HOWARD            LOC: 03213N 10131W
-----------------------------------------------------------------------------------------------
WBAN: 23005 GELOC: YQAZ EPA STATION: BIG SPRING                 TYPE: COMM           LOC: 03215N 10128W
TSP:  200.0 119.0  68.0 SO2:    2.0   2.0   3.0   PCOX:   -1.0  -1.0   NO2:   40.0  36.0  19.0
AH:     8.1  HV: 600.0  RAIN:   422.0             B2C: 10000.0         DEWPT:   6.0          TEMP:  18.0
-----------------------------------------------------------------------------------------------
WASHING INTERVAL= B , C           REPAINT INTERVAL= B , C          EXPECTED CORROSION DAMAGE= A , C
```

WESTOVER AFB STATE: MA COUNTY: PIONEER VALLEY LOC: 04212N 07232W

WBAN: 14703 GELOC: YTPM EPA STATION: CHICOPEE TYPE: IND LOC: 04211N 07236W
TSP: 137.0 121.0 55.0 SO2: 94.0 76.0 27.0 PCOX: -1.0 -1.0 NO2: 149.0 134.0 62.0
AH: 6.2 HV: 450.0 RAIN: 1151.0 D2C: 10000.0 DEWPT: 4.0 TEMP: 9.0

WASHING INTERVAL= C , C REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= C , C

WHITEMAN AFB STATE: MO COUNTY: BETTIS LOC: 03843N 09333W

WBAN: 13930 GELOC: YWHG EPA STATION: SEDALIA TYPE: IND LOC: 03841N 09317W
TSP: 256.0 146.0 63.0 SO2: -1.0 -1.0 -1.0 PCOX: -1.0 -1.0 NO2: -1.0 -1.0 -1.0
AH: 7.6 HV: 550.0 RAIN: 874.0 D2C: 10000.0 DEWPT: 6.0 TEMP: 13.0

WASHING INTERVAL= B , C REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= A , C

WI ANG GEN MITCHELL STATE: WI COUNTY: MILWAUKEE LOC: 04257N 08754W

WBAN: 14839 GELOC: HTUV EPA STATION: MILWAUKEE TYPE: COMM LOC: 04302N 08755W
TSP: 78.0 77.0 47.0 SO2: 8.0 5.0 5.0 PCOX: -1.0 -1.0 NO2: 83.0 73.0 47.0
AH: 6.0 HV: 500.0 RAIN: 747.0 D2C: 10000.0 DEWPT: 3.0 TEMP: 8.0

WASHING INTERVAL= C , C REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= C , C

WI ANG MADISON STATE: WI COUNTY: DANE LOC: 04308N 08920W

WBAN: 94811 GELOC: NXHE EPA STATION: MADISON TYPE: COMM LOC: 04304N 08922W
TSP: 266.0 120.0 57.0 SO2: 27.0 20.0 12.0 PCOX: -1.0 -1.0 NO2: 54.0 52.0 33.0
AH: 5.9 HV: 500.0 RAIN: 780.0 D2C: 10000.0 DEWPT: 3.0 TEMP: 8.0

WASHING INTERVAL= C , C REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= C , C

WI ANG VOLK FLD STATE: WI COUNTY: LA CRS LOC: 04352N 09115W

WBAN: 14920 GELOC: YAQF EPA STATION: LA CROSSE TYPE: COMM LOC: NA
TSP: 375.0 314.0 101.0 SO2: 34.0 32.0 15.0 PCOX: -1.0 -1.0 NO2: 76.0 67.0 42.0
AH: 5.9 HV: 500.0 RAIN: 750.0 D2C: 10000.0 DEWPT: 2.0 TEMP: 8.0

WASHING INTERVAL= B , B REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= B , B

WILLIAMS AFB STATE: AZ COUNTY: MARICOPA LOC: 03318N 11140W

WBAN: 23104 GELOC: YZJU EPA STATION: MESA TYPE: COMM LOC: NA
TSP: 264.0 233.0 101.0 SO2: 42.0 40.0 8.0 PCOX: -1.0 -1.0 NO2: -1.0 -1.0 -1.0
AH: 7.6 HV: 600.0 RAIN: 186.0 D2C: 10000.0 DEWPT: 4.0 TEMP: 22.0

WASHING INTERVAL= B , B REPAINT INTERVAL= B , C EXPECTED CORROSION DAMAGE= A , B

WRIGHT PATTERSON AFB STATE: OH COUNTY: MONTGOMERY LOC: 03949N 08403W

WBAN: 13840 GELOC: ZHTV EPA STATION: DAYTON TYPE: RES LOC: 03948N 08411W

TSP: 140.0 120.0 71.0 SO2: 205.0 182.0 22.0 PCOX: 372.0 353.0 NO2: 0.0 0.0 47.0

AH: 7.5 HV: 550.0 RAIN: 879.0 D2C: 10000.0 DEWPT: 6.0 TEMP: 12.0

WASHING INTERVAL= B , C REPAINT INTERVAL= B , B EXPECTED CORROSION DAMAGE= A , B

WURTSMITH AFB STATE: MI COUNTY: OSCODA LOC: 04427N 08324W

WBAN: 14808 GELOC: ZJXD EPA STATION: ALPENA TYPE: NA LOC: 04504N 08325W

TSP: 440.0 307.0 76.0 SO2: -1.0 -1.0 -1.0 PCOX: -1.0 -1.0 NO2: -1.0 -1.0 -1.0

AH: 5.9 HV: 500.0 RAIN: 750.0 D2C: 10000.0 DEWPT: 3.0 TEMP: 7.0

WASHING INTERVAL= B , C REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= B , C

WV ANG KANAWHA CO APRT STATE: WV COUNTY: KANAWHA LOC: 03822N 08136W

WBAN: 13866 GELOC: LYDH EPA STATION: CHARLESTON TYPE: MOBILE LOC: 03822N 08135W

TSP: 124.0 106.0 54.0 SO2: -1.0 -1.0 -1.0 PCOX: -1.0 -1.0 NO2: -1.0 -1.0 -1.0

AH: 8.3 HV: 500.0 RAIN: 1113.0 D2C: 10000.0 DEWPT: 7.0 TEMP: 14.0

WASHING INTERVAL= B , C REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= B , C

WV ANG MARTINSBURG MUNI APRT STATE: WV COUNTY: MINERAL LOC: 03924N 07759W

WBAN: 13734 GELOC: PJUY EPA STATION: KEYSER TYPE: RES LOC: 03926N 07859W

TSP: 104.0 93.0 51.0 SO2: -1.0 -1.0 -1.0 PCOX: -1.0 -1.0 NO2: -1.0 -1.0 -1.0

AH: 7.7 HV: 450.0 RAIN: 923.0 D2C: 10000.0 DEWPT: 6.0 TEMP: 12.0

WASHING INTERVAL= B , C REPAINT INTERVAL= C , C EXPECTED CORROSION DAMAGE= B , C